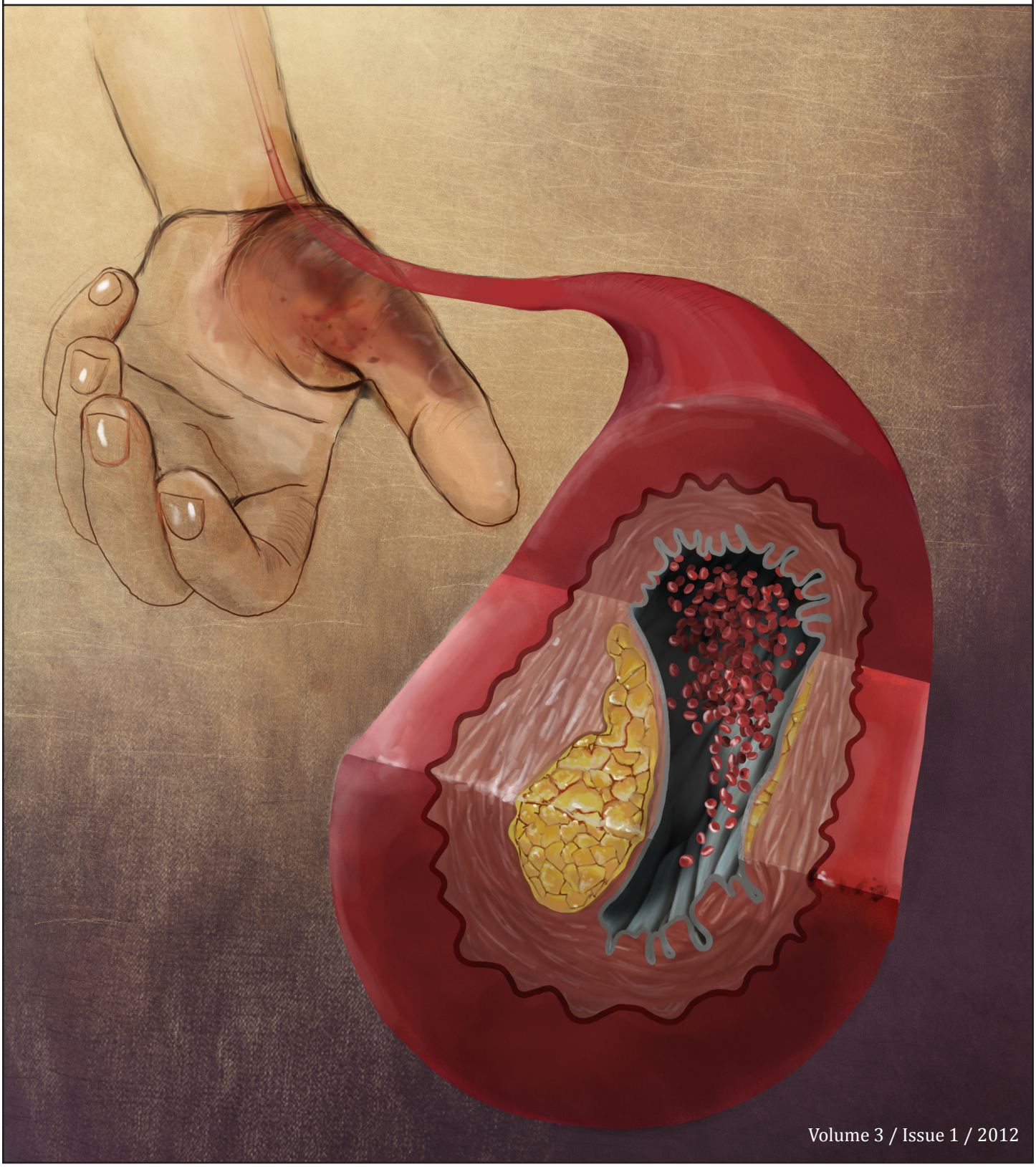
HEALTH SCIENCE INQUIRY

A publication platform for graduate students to discuss, discover, and inquire…



Volume 3 / Issue 1 / 2012

TABLE OF CONTENTS
VOLUME 3 / ISSUE 1 / 2012

Table of Contents

Main Submissions

Judging Panel

Molecular, Genetic and Clinical Research in Obesity and Diabetes

The Impact of Nutrition on Obesity and Diabetes

Table of Contents

A Sociological View on Obesity and Diabetes

Cover Design

Sara Vukson

Description of Cover Design: Diabetes plays a large role in contributing to vascular disease and other compilations. Atherosclerosis for instance, decreases blood flow by narrowing the arterial walls. This illustration shows the pathology of the artery and resulting necrosis of the starved tissue in the thumb.

About the Artist: Sara Vukson is currently a first year graduate student in the Biomedical Communications program at the University of Toronto. Her previous academic experience is at the University of Guelph where she majored in Molecular Biology and Genetics and minored in Statistics. Sara has spent a lot of time drawing at different museums including the Body Worlds Exibit, and did portfolio work with the Animation Portfolio Workshop.

HEALTH SCIENCE INQUIRY TEAM

Call for Submissions (Issue #4. June 2013)

HEALTH SCIENCE INQUIRY
A publication platform for graduate students to discuss, discover, and inquire…

Issue #4

Mental Health and Neurological Disorders

June 2013

Health Science Inquiry will be publishing a new issue every year (June), and we welcome all Canadian graduate students to submit to us. We will be focusing on **Mental Health and Neurological Disorders** for our next issue, and although the full details are still being worked out, we will once again be partnering with a peer-reviewed journal and be implementing a similar competition for students. In addition to these structured commentaries, we will also be accepting news articles and creative editorial pieces for the next issue of Health Science Inquiry. If you're interested in writing a piece or have any questions about our next issue, visit our website (**http://hsinquiry.sa.utoronto.ca**) or email us (**healthscienceinquiry@gmail.com**)!

Special Thanks

International Journal of Obesity

SPONSORSHIP

*This year, HSI will be donating **50%** of all sponsorship proceeds to a charitable donation in the area of diabetes and obesity research.*

The charity we will be donating funds to this year is **The Canadian Diabetes Association**.

Canadian Diabetes Association

The Canadian Diabetes Association is leading the fight against diabetes by helping people with diabetes live healthy lives while also working to find a cure. They accomplish this by: Providing people with diabetes and healthcare professionals with education and services, advocating on behalf of people with diabetes, supporting research and translating research into practical applications.

2012 Sponsors

INTRODUCTION

Letter from the Editor-in-Chief

Dear Readers

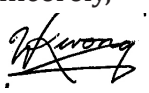
It is with great pleasure that I am able to present another issue of Health Science Inquiry (HSI). Another year has passed and HSI continues to grow with the help of a talented group of students. Our 2011-2012 HSI Team consists of over 70 Canadian graduate students who have all spent a great deal of time putting together this year's publication. With membership from all across the country, HSI continues to serve as a national platform for student involvement and discussion.

As always, we are indebted to the excellent submissions submitted by graduate student writers. The theme for this year's issue is obesity and diabetes, and our Main Submissions section features 27 commentaries spanning a range of different topics. Partnering with the International Journal of Obesity this year continues our trend of international partnerships, which has previously resulted in HSI commentaries being published in both The Lancet Infectious Diseases (2010) and the Canadian Medical Association Journal (2011). To that end, we would like to thank Drs. Richard Atkinson and Ian Macdonald (Editors, International Journal of Obesity) for providing students with this great opportunity.

In addition to our Main Submissions section, this issue also features News Articles, Dialogue Pieces and Artistic Images, all of which were introduced in our 2011 publication. Our sponsorship efforts are once again aimed at benefiting a not-for-profit organization, so this year 50% of our sponsorship funds will be donated to the Canadian Diabetes Association.

With obesity and diabetes being such a prevalent topic in today's culture, the bredth of knowledge presented in this issue will hopefully be informative and engaging to our readers. Putting together this year's publication was an absolute joy, so on behalf of the entire HSI team, I hope you enjoy the following issue!

Sincerely,



Wilson Kwong
Founding Editor-in-Chief

ARTISTIC IMAGES

By collaborating with numerous talented graduate students across the country, we are able to feature an Artistic Images section to showcase various artistic interpretations of healthcare and the medical sciences.

Artistic Images

Gurpreet Sehra

Gurpreet Sehra was born and brought up in the Greater Toronto Area. She is an artist who is working primarily in paint and video. She has completed her Honours Bachelor of Arts Degree and Diploma Program in Art and Art History and Sociology from the University of Toronto and Sheridan Institute of Technology and Advanced Learning. She is currently working on her Master of Fine Art degree at The University of Manitoba.

In her current body of work she is concerned with questioning the construction of her identity, which is closely tied with questioning the construction of Sikh-Punjabi masculinity in the Canadian diaspora.

Both images are based on microscopic photographs. The microscopic images are beautiful and reveal abstract forms, shapes and colours that are unlike those we see in nature everyday. This makes these photographs the perfect source material for a painting.

Artistic Images

Natalia Burachynsky

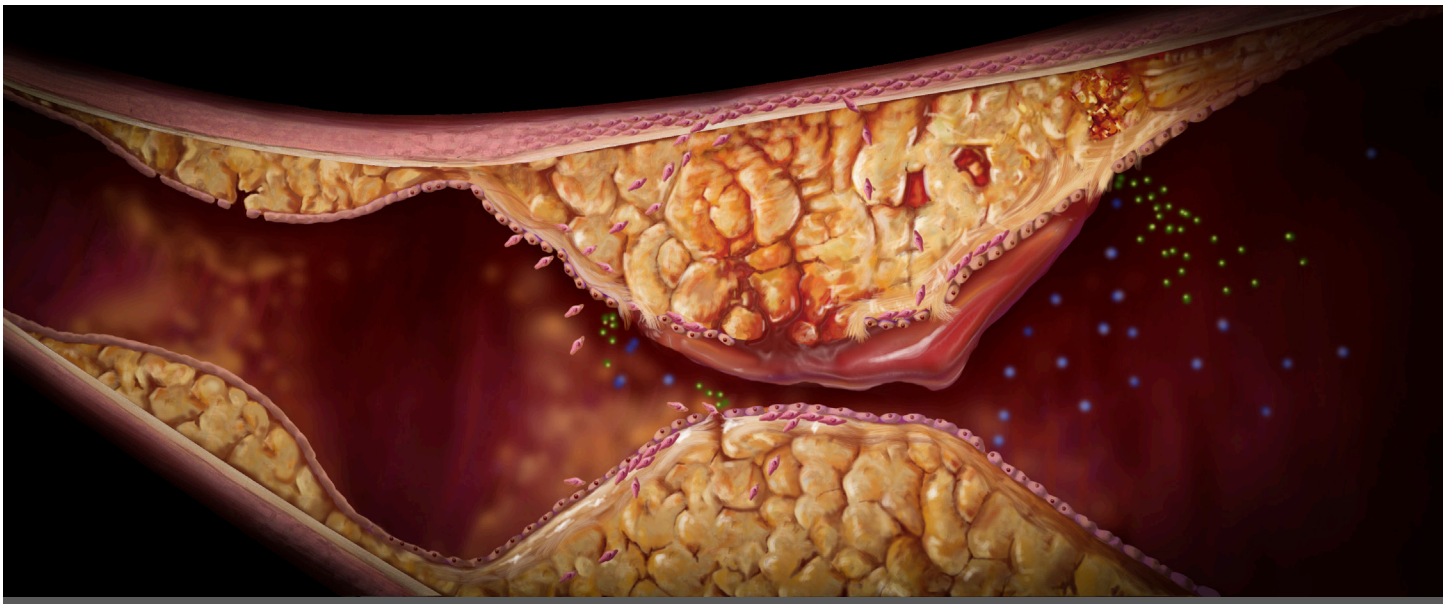
Natalia Burachynsky is a 2nd year graduate student in Biomedical Communications at University of Toronto.

Originally from Winnipeg, Manitoba she completed her BSc in Ecology at the University of Manitoba. After her BSc, she worked as a photographer in New Zealand for a year. Travelled throughout Asia and Europe for another year and then returned to Canada to begin my MSc.

She is passionate about the biological sciences, traditional art and health care, thus, a career educating scientists, doctors, students and the general public with beautiful imagery was a natural fit.

Cholesterol Molecule. Natalia Burachynsky. Adobe Photoshop CS5.5.

This image was created as part of a Pathology Process illustration depicting the process of Atherosclerosis and how the disease leads to the formation of thickened plaques within arterial walls.



Atherosclerosis. Natalia Burachynsky. Adobe Photoshop CS5.5.

This image was created as part of a Pathology Process illustration depicting the process of Atherosclerosis, the hardening of artery walls. When pieces of clots or the plaque break off, they cause blockage further down, which can result in heart attacks, strokes and pulmonary embolism. Aneurysms may also result if the plaques weaken the the artery wall and cause the rupture of the artery.

Artistic Images

Shannon Yashcheshen

Shannon Yashcheshen is a graphic/web designer, painter, printmaker and photographer. She is originally from Yorkton/Regina, Saskatchewan, but now lives and works in Winnipeg, Manitoba. She has been an active member of the arts community for the past 13 years, is a member of several art galleries and art organizations, has extensive experience exhibiting her work in art galleries, has been nominated for and has won several prestigious art and design awards, and has worked as a graphic/web designer for several large corporations. Shannon has completed the Graphic Art Production, New Media Communications, and the Applied Photography extension programs at the SIAST Wascana campus in Regina, Saskatchewan, a Bachelor of Fine Art Degree with a double major in painting and printmaking, and a Bachelor of Arts Degree with a specialization in art history, at the University of Regina. She completed these programs with distinction and has successfully completed them while working full time as a graphic designer. Shannon is currently working on her Master of Fine Arts degree at the University of Manitoba, where she is completing advanced studies in painting, while training to be a studio art professor.

Bodyscape is a painting that strives to visually depict the relationship between the body and the the landscape. The work is part of an ongoing series that aims to depict bodies of all ages, shapes, sizes and colours. My goal in creating the work is to emphasize that all bodies are beautiful. This work in particular is autobiographical, in that it visually depicts my journey to overcome the societal pressures to conform to an unrealistically thin body type. For me, this painting was monumental in helping me see beauty in my body and overcoming that struggle. I created the work at a time when I needed o see healthy and positive images of bodies, that promote diversity rather than unattainable "perfectness".

Bodyscape. Shannon Yashcheshen. 2010.
Oil on canvas. 36" x 48".

SECTION 1: NEWS ARTICLES

News Reporters from HSI's Editorial Team investigated various issues in obesity and diabetes to present readers with insight into the latest research and initiatives across the country. Our team of reporters conducted research and interviews with key experts in a range of different topics.

News Article

Becoming 'Weight Wise': Understanding the Complexities of Obesity

Nicole Barra *(McMaster University)*
News Reporter (HSI 2011-2012)

Current obesity statistics are staggering — national statistics show that the majority or 59% of the Canadian population is considered overweight, and 1 in 4 or 5.5 million adults are classified as clinically obese.[1] Rates of childhood obesity have also dramatically increased, with the most pronounced rise in adolescents.[2] Unfortunately, the increasing prevalence of this disease is not unique to the Western world, but has become an international epidemic.[3,4] Obesity is a risk factor for a variety of chronic conditions such as diabetes, high blood pressure, heart disease, sleep apnea, osteoarthritis, and some forms of cancer; this represents a tremendous financial burden on our health care system.[5,6] Therefore, understanding the causes of this disease is critical for preventing obesity from continuing to overwhelm our health care system.

Canadian obesity experts believe that obesity's causes and treatments are not reducible to a measure of calories in versus calories out. According to Dr. Arya Sharma, Professor and Chair of Obesity Research and Management at the University of Alberta, "telling people to eat less and move more does not work," since multiple biological, psychological, and social factors contribute to the manifestation of this disease.[5,7] The multifactorial nature of obesity makes it difficult to come up with practical and simple solutions that work for everyone. Understanding the interconnections and complexity of these factors will aid in formulating effective treatment and management strategies. As the Medical Director of the Edmonton Weight Wise Program, Dr. Sharma, along with a specialized multidisciplinary team of health professionals, provides a comprehensive approach to preventing and managing excess weight and obesity through tertiary medical, psychological, and surgical interventions.[8] To qualify for treatment, adults over the age of 17 must have a body mass index (BMI) greater than or equal to 35, must not have untreated psychological disorders, must be able to attend a minimum of 10 clinic appointments within a 9-month period, and must be referred to the program by a physician. After an initial clinic assessment, a treatment plan is developed based on the patient's needs; the plan may include behaviour modification, a mental health assessment, nutritional counseling and physical activity recommendations, drug treatment and/or bariatric surgery. According to Dr. Sharma, "what makes this program different is that we try to address the etiology of obesity so for each patient we try to figure out why is this person obese, how is obesity affecting their health, and what would be an effective treatment plan". The primary goal of the clinic is "to provide individuals struggling with excess weight access to the level of care required to help better manage their weight and reduce associated health risks."

Telling people to eat less and move more does not work. - Dr. Arya Sharma

Dr. Arya Sharma, Professor and Chair of Obesity Research and Management at the University of Alberta and Scientific Director of the Canadian Obesity Network.

Dr. Sharma is revolutionizing how obesity is managed clinically by creating novel diagnostic tools to aid health professionals in predicting obese patients' health risk outcomes. Dr. Sharma and his colleague Dr. Raj Padwal from the University of Alberta developed the Edmonton Obesity Staging System (EOSS), a set of criteria designed to classify patients into specific categories based on their BMI and state of health. This innovative system provides

insight into the patient's mental, medical, and functional problems related to their excess weight. "Currently obesity is determined by BMI, which is based on your size, so BMI tells me how big a patient is but EOSS tells me how sick a patient is" says Dr. Sharma. "Within each level of BMI you can have patients who have no obesity-related health problems at all or people who have a lot of obesity-related health problems." In a paper published last year in the Canadian Medical Association Journal, Drs. Sharma and Padwal examined the efficacy of using EOSS in overweight and obese individuals and found that EOSS scores were a strong predictor of increased mortality independent of the individuals' waist circumference, presence of metabolic syndrome, and BMI[9]. Another study published last year in Applied Physiology, Nutrition, and Metabolism showed that obese individuals with low EOSS scores had a comparable mortality risk to lean individuals and were less likely to die from cardiovascular complications.[10] "EOSS puts an emphasis on individualized treatment needs which depends on how sick or at-risk a patient is. Because obesity requires long-term treatment and can be costly, knowing which patients need to be most urgently treated to improve their health and which do not, can save health-care dollars," says Dr. Sharma. The EOSS diagnostic tool is currently being used at the Edmonton Weight Wise Program's clinic as well as in similar clinics across the nation and overseas.

Dr. Sharma states that "obesity is a chronic heterogeneous multifactorial condition that threatens or affects an individual's mental and socio-economic health." Therefore, multidisciplinary approaches and knowledge translation between fields are critical to understanding the complexities of this disease. To facilitate this, a network providing knowledge transfer between individuals from various medical and research disciplines has been established. The Canadian Obesity Network (CON) is the largest national network consisting of over 6,000 members, bringing together "obesity researchers, health professionals, decision markers, and other folks with a 'professional' interest in obesity from across the globe." As its Scientific Director, Dr. Sharma says that the purpose of the network is to "help connect all these folks and foster an exchange of ideas [that] may provide new solutions to Canada's emerging obesity epidemic." Since 2005, CON has hosted regional and national workshops aimed at training researchers, health professionals and students with "a keen interest in obesity prevention and management." National initiatives addressing childhood obesity are also supported by CON. Over the past four years, the main goal of the network has been addressing weight bias and weight-based discrimination since members like Dr. Sharma agree that "this is the central problem at the very heart of finding solutions to the obesity issue." Anyone with a professional interest in obesity can register for free at www.obesitynetwork.ca and "become part of Canada's professional obesity community."

The Canadian Obesity Network (CON) is the largest national network consisting of over 6,000 members bring together people with a professional interest in obesity from around the globe.

Currently obesity is determined by BMI, which is based on your size, so BMI tells me how big a patient is but EOSS tells me how sick a patient is
- Dr. Arya Sharma

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Nicole Barra

Nicole Barra completed her undergraduate degree at the University of Toronto in Human Biology. She is currently pursuing a PhD in Infection and Immunity at McMaster University's Medical Sciences program in an area that combines two great disciplines - obesity and immunology. Her project involves examining the role of immune factors in regulating adipose tissue. Her research interests include understanding the role of immunity in modulating metabolism during the onset and progression of obesity and diabetes. She is also a member of the Canadian Obesity Network and was fortunate to attend the fifth annual Obesity Summer Bootcamp.

News Article

Nutrigenomics: Moving towards Personalized Nutrition for Obesity Prevention

Anna DeBoer *(University of Guelph)*
News Reporter (HSI 2011-2012)

If you had the opportunity to simply provide a saliva sample, and in 6 weeks receive a list outlining your relative risk of developing type 2 diabetes and other diseases, would you take it? This opportunity is currently available from a US company called 23andme, which offers genetic testing to uncover disease risks using genetic markers with known associations.[1] In response to public curiosity, commercial programs like 23andme and others apply genomic technologies, i.e. gene mapping and DNA sequencing, to disease prevention, but in truth they are only scratching the surface in the application of "omic" technologies to health. The term "omic" means "complete" or "all" based on a Greek suffix used to describe study areas in biology.[2] Of the 50 or so "omic" terms coined so far, the field of nutrigenomics may soon be able to offer people more information on disease risk and prevention.[2] Nutrigenomics allows researchers to study diet-gene interactions, or more generally, the role of genes in

If you had the opportunity to simply provide a saliva sample, and in 6 weeks receive a list outlining your relative risk of developing type 2 diabetes and other diseases, would you take it?

response to changes in energy balance (food intake) or diet composition (micro- and macro-nutrients).[3] What's more, with nutrigenomics it may one day be possible to make personalized dietary recommendations based on genotype in order to help people lose weight, optimize their health, or help prevent disease onset/exacerbation, especially for at risk populations prone to obesity and type 2 diabetes.

The field of nutrigenomics consists of two distinct but related areas called nutrigenetics and nutrigenomics. Nutrigenetics is the study of how an individual's genotype affects their response to diet, whereas nutrigenomics

A recent large-scale European Framework VI clinical intervention study called Diet, Obesity and Genes identified unique gene expression profiles associated with maintainance of a new lower weight following a low-calorie dietary intervention.

is the study of how diet or specific nutrients affect gene expression, protein function, and subsequent downstream cell signalling pathways.[2] Thus, it is now well accepted that to optimize health and prevent disease, one must consider environment and hereditary factors simultaneously.[2] Importantly, nutrigenomic/nutrigenetic approaches allow researchers to study complex diseases like obesity and type 2 diabetes that are caused by a combination of genetic and environmental risk factors, such as diet.

It has been estimated that the heritability of obesity is between 40-70%;[4] however, teasing out the cause of obesity is difficult because it is most commonly a polygenic (multi-factorial) disease with strong environmental factors. Polygenic forms of obesity are complex in nature where the adipose phenotype, a key tissue studied, is dependent on developmental, behavioural, environmental (e.g. diet composition), and genetic factors.[5] In an effort to understand the causes of polygenic obesity, studies in the past few decades have unravelled genes that act as nutrient sensors, or genes that are implicated in obesity and diabetes pathogenesis. These findings have revealed that we have genes regulated by various micro- and macro-nutrients.[6] For example, dietary fatty acids and their metabolites can bind directly to, and change the abundance/activity of specific transcription factors to control fat and carbohydrate metabolism.[6] Moreover, nutrigenetic research in humans has revealed that in one's genotype there is genetic variation

in nutrient-sensing pathways and obesity-related pathways that may alter their response to diet, and ultimately impact their risk of becoming obese or diabetic.[7]

Although it has been possible to study nutrient-sensing and obesity-related genes/pathways in isolation in the past, it has now become appreciated that every human genome consists of a unique mosaic of polymorphisms for these genes that need to be appreciated in combination to make dietary recommendations and assess risk.[2] Dr. David Mutch, Assistant Professor of Nutrigenomics at the University of Guelph suggests that we need to get away from studying genes in an isolated "one at a time" manner, and rather study biological systems or networks. This is especially important in humans who are each genetically distinct (see Figure 1). Haplotypes consist of a unique combination of single nucleotide polymorphisms (SNPs), or different sites in the DNA sequence where individuals differ by one base pair that is inherited together in a specific chromosome region.[8] Humans are about 99.9% genetically similar, and most genetic variation is accounted for by the 1 million SNPs found in the human genome, particularly by rare SNPs that have a frequency of around 1%.[8] Haplotypes can be used to look for genetic variation among humans, and hopefully identify genes or chromosome regions (alleles) that can account for some disease susceptibility.[8] The International HapMap project is an international collaboration that has aimed to link genetic variation to disease states by creating a database of all known variation.[8]

Nutrigenomics researchers make use of the HapMap database to identify haplotypes associated with diet-gene interactions in obesity and type 2 diabetes. For example, Mutch and colleagues looked at polymorphisms in two human fatty acid desaturase genes (Fads1/2), which encode desaturase enzymes responsible for altering tissue lipid profiles.[9] Increased delta 5 desaturase activity (Fads1) may lead to a greater production of lipids like arachadonic acid and its pro-inflammatory derivatives, whichare implicated in the pathogenesis of metabolic diseases including obesity and type 2 diabetes.[9] Here, they looked at the relationship between SNPs for Fads1/2 and fatty acid desaturase activity in various ethnic populations from the Toronto Nutrigenomics and Health cohort. Most notably, they found a SNP in Fads1 where major/minor allele frequencies varied between Asians and Caucasians; however, regardless of ethnic background, carriers of the "T" rather than the "C" allele were associated with greater desaturase activity.[9] This study shows that there is genetic variation in the Fads gene locus in Caucasians and Asians, which is reflected by differences in desaturase activity. This research helps us understand why there are specific differences in people's lipid profiles, and may eventually contribute to improved dietary strategies to manage obesity characterized by altered lipid profiles.[9]

In addition to nutrigenetic research on haplotypes, human obesity is also being studied from a nutrigenomic standpoint (the effect of diet on genes). Mutch relates that associative nutrigenetic studies do not always agree probably because of differences in the population studied and the environmental factors affecting those populations. He goes on to propose that in order to further nutrigenomic research and reach the goal of personalized nutrition, large-scale clinical trials are needed to detect rare genotypes

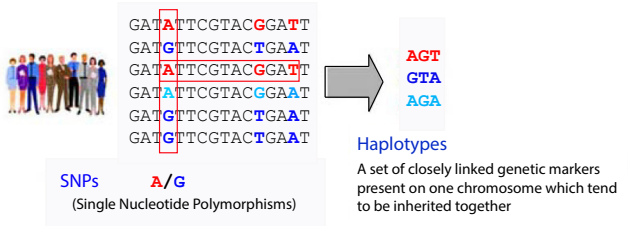

Figure 1: Each row of DNA sequence represents the chromosome of a different person. Coloured letters represent SNPs at specific chromosome locations. *Image kindly made accessible through BioLicence open source information, http://omics.org/index.php/SNPenomics*

and elucidate diet-gene interactions. A recent large-scale European Framework VI clinical intervention study called Diet, Obesity and Genes (abbreviated as DioGenes), recruited over 548 obese subjects to complete an 8-wk low-calorie diet, and then selected a subset of 40 non-diabetic women to identify changes in adipose tissue gene expression (mRNA; transcriptome) that took place during the diet.[10] Moreover, the study went further to identify unique gene expression profiles in those who maintained their new weight following the low-calorie diet, versus those who re-gained the weight following the intervention. Using bioinformatic software to identify gene sets, a distinct profile of genes that are up or downregulated in response to certain stimuli (e.g. oxidative stress), Mutch and his colleagues were able to tease out candidate pathways that were modulated by the low-calorie diet in both weight maintainers and weight re-gainers (see Figure 2).[10] In short, the authors were able to conclude that there may be a genetic basis for the ability to maintain weight loss following the low-calorie diet in women.[10]

In summary, current nutrition research in humans consists of cutting edge nutrigenetic studies like associative studies

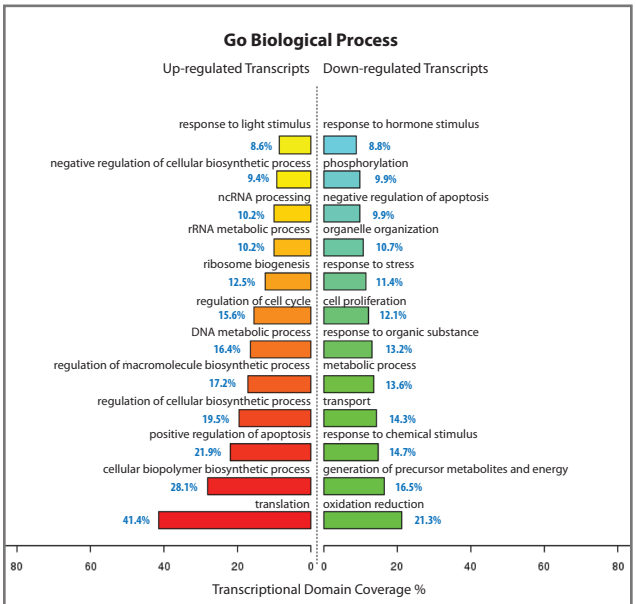

Figure 2: Bioinformatic output from Functional Network Analysis (© INSERM) showing the percent of up or down-regulated cellular pathways/processes from the Gene Ontology Biological Process database after weight loss in a treatment group of women compared to a control. This is done by analyzing microarray data of the transcriptome *(unpublished data, image courtesy of Dr. D. Mutch).*

that link haplotypes to disease states, and nutrigenomic studies like large clinical trials that aim to understand how dietary interventions affect gene expression and downstream signalling. These studies will unravel diet-gene interactions and identify the relative contribution of genetics and environmental factors in complex diseases like obesity (polygenic) and type 2 diabetes. Finally, researchers like Mutch hope to see their recommendations for personalized nutrition based on nutrigenomic research come to fruition in the next decade.

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Anna DeBoer

Anna is a PhD student at the University of Guelph in the field of nutrition, metabolism and exercise. Anna's research revolves around studying the chronic inflammatory component of obesity, and understanding how long chain omega-3 polyunsaturated fatty acids like those found in fish oil decrease inflammation in adipose tissue. In her spare time, Anna likes to stay active hiking and travelling, and also enjoys freelance writing to encourage knowledge translation to the general public.

News Article

Buckwheat may Help Control Satiety and Reduce Risk Factors for Type 2 Diabetes

Stephanie Caligiuri
(University of Manitoba)
News Reporter (HSI 2011-2012)

A balanced diet containing functional foods can play a crucial role in preventing one of the most prevalent diseases in Canada, type 2 diabetes. Research on functional foods has increased tremendously over the last decade; functional foods contain components that provide health benefits, such as reducing chronic disease risk, above what typical nutrients can offer. Researchers at the University of Manitoba and Canadian Centre for Agri-Food Research in Health and Medicine have investigated a potential role for functional foods, specifically buckwheat, in reducing the risk for type 2 diabetes.

Excess body fat is one of the strongest risk factors for type 2 diabetes, with the Canadian Diabetes Association reporting that 80-90% of patients with type 2 diabetes are overweight or obese.[1] In an effort to prevent this susceptible population from developing type 2 diabetes, several researchers have focused on dietary interventions that may help control hunger, blood sugar levels, and body weight.

In an attempt to prevent the development of type 2 diabetes, several researchers have focused on dietary approaches which may help control hunger, blood sugar levels, and body weight.

Danielle Stringer, a PhD candidate at the University of Manitoba, is currently investigating the beneficial properties of buckwheat. Buckwheat is similar to a cereal grain and is quite versatile as it can be incorporated into soups, porridge, salad, or flour. Buckwheat is low in fat and high in fibre and protein.

Buckwheat seeds are a very affordable functional food ($0.70/100 g), making it a cost-effective dietary intervention. Given that individuals of lower socioeconomic statuses have a higher risk of developing type 2 diabetes,[4] buckwheat may be a viable food choice to enhance health in lower socioeconomic groups.

Researchers at the University of Manitoba have investigated a potential role for functional foods, specifically buckwheat, in reducing the risk for type 2 diabetes.

Stringer stated, "I wanted to research the effect of functional foods on diabetes because there is great research potential for nutrition interventions and improving the health and quality of life for patients with diabetes. I performed a study on buckwheat in particular because my lab has produced results both in vitro and in animal studies that showed the potential of buckwheat in lowering blood glucose levels and potentially altering satiety. Buckwheat is thought to contain insulin-like compounds that has the potential to maintain blood sugar levels and reduce the incidence of type 2 diabetes."

Other researchers also interested in buckwheat have reported beneficial effects. Zhang et al. (2007) found that the rate of abnormal blood glucose levels was 1.9% in Mongolian-Chinese participants who consumed buckwheat seeds compared to 7.3% in those who did not.[2] In addition, the researchers found that those who consumed buckwheat had significantly lower levels of triglycerides, cholesterol, and low density lipoprotein cholesterol (bad cholesterol) than the non-buckwheat-consuming population.[2] Therefore, buckwheat may provide additional benefits for the promotion of health.

Animal studies provide additional evidence for the favourable effects of buckwheat. A study performed by

Kawa et al. (2003) found that buckwheat concentrate (10 and 20 mg/kg body weight) effectively lowered blood glucose by 12-19% in diabetic rats.[3]

Stringer is currently performing research on buckwheat and its potential role in aiding type 2 diabetes patients with blood glucose control and satiety. Stringer wants to further investigate the correlations reported by Zhang and Kawa using in vitro studies and randomized controlled clinical trials.

Curran and Stringer (2010) sought to identify the mechanism that allows buckwheat to stabilize blood glucose levels using H411E rat hepatoma cells. Curran and Stringer hypothesized that the compounds D-chiro-inositol and myo-inositol in buckwheat would have insulin mimetic properties. They tested a buckwheat concentrate, D-chiro-inositol and myo-inositol separately. The buckwheat concentrate had insulin mimetic effects on protein phosphorylation events during glucose uptake and metabolism; however the inositol compounds were not responsible for these effects. Curran and Stringer concluded that buckwheat has insulin-like effects in controlling blood glucose levels and that those effects must be attributable to compounds in buckwheat other than the inositols.[5]

Stringer has also investigated the effect of buckwheat in humans. Her study included 12 healthy participants and 12 patients with diabetes who controlled their blood glucose levels through diet alone. She produced crackers using buckwheat flour and asked participants to consume 75 g of either buckwheat crackers or rice crackers (control) in a fasted state. The 75 g dose of buckwheat crackers contained 46 g of whole grain buckwheat flour. Gastrointestinal hormones that can affect glucose metabolism such as glucagon like peptide-1 (GLP-1), gastric inhibitory polypeptide (GIP), as well as hormones responsible for controlling satiety such as ghrelin, peptide YY, and pancreatic polypeptide, were analyzed after consuming the crackers.

Stringer noted, "the buckwheat crackers increased the secretion of hormones associated with satiety in both the healthy control group and the patients with type 2 diabetes." The changes in hormone secretion can translate to reductions in appetite and improved eating patterns. With longer feelings of fullness, individuals will be less likely to eat more and will also be more likely to obtain normal blood glucose levels. This will also aid individuals in achieving and maintaining a healthy body weight, which can help to reduce their risk of developing type 2 diabetes.

Stringer concluded, "There lies great potential with buckwheat products for patients with diabetes to help maintain their body weight and glucose control. The implications of this research can translate into the incorporation of the active ingredients of buckwheat into a variety of food products, which can offer consumers a cost-efficient means to aid in the prevention or management of type 2 diabetes."

Acknowledgements

Special thanks to Danielle Stringer, PhD candidate, for her time and willingness during the interview.

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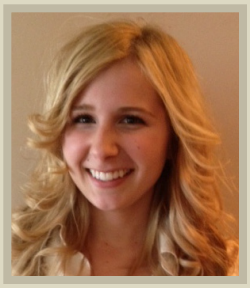

Stephanie Caliguri

Stephanie Caligiuri is completing her Master of Science degree in Human Nutritional Sciences at the University of Manitoba. Her research has focused on the pathophysiology of obesity related kidney disease and how interventions with altered dietary fatty acid compositions may ameliorate or accelerate the disease. Stephanie plans to start her PhD in the Faculty of Medicine this Fall in which she will be running a clinical trial investigating the influence of flaxseed and flax oil on vascular health and hypertension. Ms. Caligiuri aspires to be a researcher focusing on using functional foods and natural health products as treatment/preventive measures for chronic disease.

News Article

Addressing and Managing the Increasing Rate of Obesity among Canadian Youth

Sofia Huroy *(University of Toronto)*
News Reporter (HSI 2011-2012)

The obesity epidemic continues to spread at an alarming rate. Since the late 1970s, there has been a significant rise in the number of overweight and obese people. This rise is seen in many parts of the world, across all age groups and in both genders. And Canada is no exception. Recent *Statistics Canada* data have shown that 26% of Canadian youth aged 2-17 years are overweight or obese. With a growing population of overweight or obese children, there is strong pressure to implement prevention programs that promote healthy nutrition and increased physical activity among children. Therefore, preventing childhood obesity has recently become a priority among different governments, including Canada. Surprisingly, until about 25 years ago, type 2 diabetes was uncommon in children and adolescents, and rarely seen in individuals under the age of 40. As obesity becomes more prevalent in younger populations, without intervention, these youth face serious health complications in the future. This will no doubt cause further strain on Canada's healthcare system.

STOMP provides various types of treatments such as cognitive behavioural therapy, medications, specialized diet and bariatric surgery.

Obesity is a complex condition. Multiple factors such as genetics, lifestyle, diet, overall physical and emotional health, and race/ethnicity can influence the development of obesity in children and adolescents. Other factors such as television viewing, and advertising have also been found to play a role in obesity development. Obesity is associated with increased risk to cardiovascular disease, hypertension, type II diabetes mellitus, menstrual irregularities, obstructive sleep apnea, to name a few.

Experts agree the best method to prevent obesity is to start early. Across Canada multiple paediatric Weight Management Programs have been put in place to combat and treat obesity in youth. One such program is the STOMP (SickKids Team Obesity Management Program), established at The Hospital for Sick Children (SickKids) in 2010.

Dr. Catherine Birken is a general paediatrician at SickKids, and co-director of STOMP. She reveals the idea of STOMP came into existence about 5 years ago. Overweight/obese children were being assessed by many specialists all over the hospital, with each specialist addressing one particular issue. That is because some children also had significant obesity-related co-morbidities or significant co-existing chronic illnesses such as tumours or medications induced obesity. Thus STOMP came about, to address all health issues of the child/adolescent as a team. When the idea was brought forward to the Ontario Ministry of Health and Long-Term Care, the ministry agreed to fund it for 3 years, with enough funding for 50 children per year.

All children enrolled in STOMP must be referred by a Health Care Professional, and have a BMI > 99th percentile, or a BMI > 95th percentile plus a significant obesity-related co-morbidity. Then, the adolescents will be assessed by the STOMP team before joining the program. The STOMP healthcare professional team includes a general paediatrician, a paediatric endocrinologist, a surgeon, a nurse practitioner, a dietician, an exercise therapist, a psychologist, a social worker, and collaborations with

other healthcare professionals with various specialties (e.g. adolescent medicine and cardiology).

STOMP is a two-year intensive program. Along with the healthcare professionals, the adolescent group between the ages of 12-17 years partake in weekly group sessions. A major focus of the program is psychological and mental health support in a group setting. The caregivers of the patients also have their own group sessions. Dr. Birken shares that "[STOMP] is fortunate to have significant mental health, dietetics and physical activity expertise, and if affective there is an opportunity to expand."

Countless studies have shown that obesity affects mental health as well as physical health. Adolescent obesity, like adult obesity, is associated with numerous psychological problems. Obese children and adolescent are also teased, and as a result suffer from low self-esteem, nega¬tive body image, and depression. Furthermore, obese individuals have been shown to be discriminated against employment and educational opportunities.[1] Stigma against weight gain is further exuberated through the media. The media often portrays being thin with positive messages, while being overweight with negative messages. Thus, Dr. Birken explains STOMP is unique because it is "a program designed specifically for adolescents… there are not many programs out there for adolescents who suffer from morbid obesity." She further adds that due to the severity of health among the children, the program is "very psychology based…heavy on mental health."

STOMP provides various types of treatments such as cognitive behavioural therapy, medications, specialized diet and bariatric surgery. However, Dr. Birken clarifies that "only a small part of the program is surgery." Less than 10 children have had surgery so far. She points out that "[STOMP has] a rigorous process to identify children who are good candidates for surgery." To qualify patients must show willingness to lifestyle changes after surgery. Some of the criteria to have surgery include that the adolescents must have finished growing, i.e. around 16-18 years of age, and consent and support of family to be successful.

The social and psychological impact of obesity, especially on females, is staggering. Adolescent girls are constantly bombarded with messages that a slender body is more attractive and desirable. As such, body dissatisfaction is more common in females. This can lead to eating disorders and other mental health problems.[2,3] Dr. Birken agrees that there is a "huge bias" towards overweight/obese individuals, but points out that the outcome of the surgeries is "not always affective" and it is not a "tool to be used to just become thin." She shares that "in STOMP we are concerned with health outcomes, not only BMI. These outcomes include improved quality of life, school attendance, as well as reduced obstructive sleep apnea, and high cholesterol."

For the future, Dr. Birken would like to "evaluate the outcomes [of STOMP] … [and asses the] mental health and school outcomes" of the children involved with STOMP. If the program is considered successful, she would like "to advocate for more resources, and expand the program." One area she would like to expand the program is to children with mental disability but who also suffer from obesity. She states, with the current model of STOMP such individuals "can't participate in group therapy, but [stresses] that is not the only form of therapy."

Youth are an important population for obesity prevention. In addition, the probability that childhood obesity will persist into adulthood increases in adolescence. Hence, Weight Management Programs like STOMP play a key role in attempting to combat obesity early on.

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Sofia Huroy

Sofia Huroy is currently pursuing a MSc degree in Pharmaceutical Sciences at the University of Toronto, where she also received her Honours BSc. Her research is in the area of neuroscience, and focuses on the use of animal models to study the mechanism of opiate dependent tolerance.

News Article

Beyond insulin: On the Road to a Cure for Type 1 Diabetes

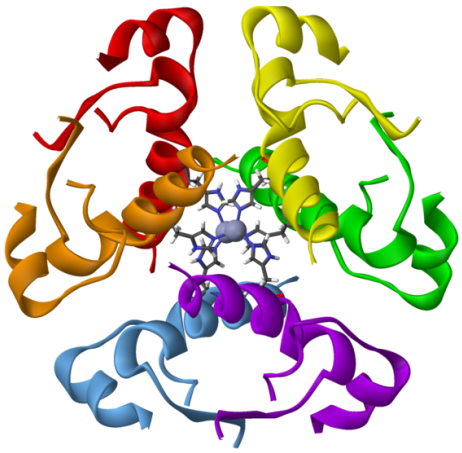
Jenna Capyk
(University of British Columbia)
News Reporter (HSI 2011-2012)

Dependence on daily insulin injections often begins in early childhood for those with type 1 diabetes, an autoimmune disorder that destroys insulin-secreting β-cells in the pancreas. The hormone insulin plays an essential role in blood glucose regulation by triggering uptake of blood glucose by body tissues. Glucose is a crucial energy source within our bodies and its level in the bloodstream is maintained within a very narrow range by insulin and other hormones. Low blood glucose starves vital organs and can lead to coma and death. In contrast, chronically high blood glucose results in damage to fine blood vessels and nerve fibres.

Type 1 diabetics are dependant on externally supplied insulin and must measure their blood glucose levels, calculate the correct amount of insulin to balance their food intake and planned activity level, and inject these insulin doses several times daily. This therapy results in unhealthy fluctuations in blood glucose. Insulin pumps can be used to supply insulin via a catheter, but even this improved treatment leaves patients dependant on drugs and equipment, and does not fully recapitulate natural insulin production.

While exogenous insulin therapies are life-saving treatments for diabetes, they fail to prevent its crippling complications, which can restrict daily activities and dramatically decrease lifespan.

While exogenous insulin therapies are life-saving treatments for diabetes, they fail to prevent its crippling complications, which can restrict daily activities and dramatically decrease lifespan. These complications include cardiovascular disease, neuropathy, blindness, kidney disease, and lower limb amputation. Consequently, type 1 diabetics in North America predecease their non-diabetic peers by over a decade, on average.



The hormone insulin plays an essential role in blood glucose regulation by triggering uptake of blood glucose by body tissues.

Alternatives treatments, which establish production and secretion of insulin within the patient's own body, hold great promise for the future of diabetes treatment. To learn more about the new treatments being developed by Canadian scientists, I talked to Dr. Timothy Kieffer, a principal investigator in the Diabetes Research Group in the Department of Cellular and Physiological Sciences at the University of British Columbia.

One area of research in Dr. Kieffer's laboratory involves using islet transplants to replace the β-cells destroyed in type 1 diabetes. The current islet transplant procedure, known as the "Edmonton protocol," entails purifying the β-cell-containing islets from the pancreas of a recently deceased donor and infusing these cells into the liver of a diabetic patient. The transplanted β-cells are able to sense glucose levels in their blood supply and release insulin, thus maintaining normal blood glucose levels.

Islet transplant surgery has great potential as a diabetes therapy, but it also has significant limitations. One major consideration, Dr. Kieffer points out, is the need for continuous immunosuppression to prevent rejection of the donor cells and to inhibit the type 1 diabetic autoimmune response against β-cells. Chronic immunosuppression carries significant risks. This surgery is therefore only recommended for diabetics with very poor blood glucose control, and is not a viable option for small children. Transplanted β-cells also lose function over time, with most

patients relying once again upon injected insulin five years post-transplant. Additionally, severely limited supplies of both donor pancreases and facilities with the equipment and expertise needed to process them limit widespread practice of islet transplantation.

Dr. Kieffer's laboratory is one group working to produce β-cells from stem cells, eliminating the requirement for donor pancreases. He explains that diabetes is in a unique position among diseases under consideration for stem cell-based therapies: "There's limited evidence, for example, that with spinal cord injury you can transplant cells and reverse the disease. With diabetes… we know it works based on islet transplant." While such a renewable source of β-cells for transplant would be life-changing for many people, there is currently no established protocol for making stem cell-derived βcells that exhibit a natural insulin secretion profile. According to Dr. Kieffer: "I do believe we're getting closer and that it will work, but we're not there yet."

Dr. Kieffer's group is also working on engineering other cells in the body to take over insulin production. Mammals have specialized intestinal cells that produce hormones secreted in response to ingested glucose. Release of these substances in the gut stimulates insulin secretion in the pancreas, and the blood levels of these hormones parallel that of insulin. Dr. Kieffer explains that, "If we can fool these gut cells to produce insulin, maybe we can reestablish the automatic meal-dependent pattern of insulin and therefore eliminate the need for insulin injections or β-cell transplant." It is an attractive concept with the potential to evade the anti-β-cell autoimmune response that characterizes type 1 diabetes. The Kieffer lab, in conjunction with the company enGene, is currently working toward producing a "gene pill" that can safely deliver the insulin gene into these gut cells and establish glucose-dependant insulin secretion. While several hurdles remain, including optimizing a safe gene delivery system and providing proof that there is no autoimmune response to the new insulin-producing cells, this approach has the potential for long-term efficacy with no dependence on exogenous insulin or immunosuppressive agents.

Alternatives treatments, which establish production and secretion of insulin within the patient's own body, hold great promise for the future of diabetes treatment.

Most patients with type 1 diabetes today face years of exogenous insulin therapy, but improvements in islet transplant technology and the prospect of gene-based therapies represent two distinct paths towards curative treatments for this devastating disease. Scientists are working toward reducing post-transplant dependence on immunosuppressive drugs by combining β-cell transplant with a more elegant form of immunosuppression. As for the limited supply of transplantable islet cells, Dr. Kieffer remarks, "looking into my crystal ball, I believe that in the not too-distant future there will be clinical trials of not donor-derived islets, but stem cell-derived islet cells going into patients." As he and his colleagues continue their work toward these goals, Dr. Kieffer expresses optimism for their eventual success: "I think that the parts are in place, and it's now just a matter of time."

Acknowledgements

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Jenna Capyk

Jenna Capyk is a recent PhD graduate from the University of British Columbia in Vancouver. Her graduate studies focused on the biochemistry of cholesterol degradation in the human pathogen Mycobacterium tuberculosis. She is a frequent podcast guest host where she enjoys making biology both accessible and entertaining. Jenna continues to engage in scientific communication through her position as a scientific marketing specialist at STEMCELL Technologies Inc., a Vancouver-based biotechnology company.

News Article

Living the DREAM: A Milestone in Canadian Research

Jonathon Torchia
(University of Toronto)
News Reporter (HSI 2011-2012)

Recently, two researchers at McMaster University completed the first human clinical trial to investigate preventative drugs in the fight against diabetes.

There is no doubt that diabetes is one of the most pressing health concerns of our generation, as more than 9 million Canadians live with diabetes or pre-diabetes (Canadian Diabetes Association). Treatment of diabetes through therapeutic intervention is a multi-billion dollar industry, and is estimated to cost the Canadian health care system $16.9 billion per year by 2020.

In the past decade and over the course of around 9 trials we have clearly shown that diabetes can be prevented.

Canada is a leader in advancing basic molecular science and clinical research in diabetes. Recently, researchers have become interested in disease prevention, as opposed to simply recurrent drug therapy, in order to lessen the burden on Canada's overwhelmed health care system.

In 2006, the DREAM trial (Diabetes REduction Assessment with ramipril and rosiglitazone Medication), co-led by Dr. Hertzel Gerstein and Dr. Salim Yusuf at McMaster University, was completed as the first clinical trial to investigate diabetes prevention as the primary end-point (available online through PubMed; ID16997664). The study showed that type 2 diabetes can be prevented by up to 60% with the use of rosiglitazone, and has put the thiazolidinedione (TZD) drugs on the radar as promising drugs for the prevention of type 2 diabetes. The following is a brief interview with Dr. Hertzel Gerstein, highlighting his personal opinions about the state and influence of Canadian diabetes research.

JT: There is an opinion amongst many people that type 2 diabetes is a "man-made" disease, and that the burden placed on Canada's health care system can be entirely prevented by maintaining a healthy lifestyle. Is this true?

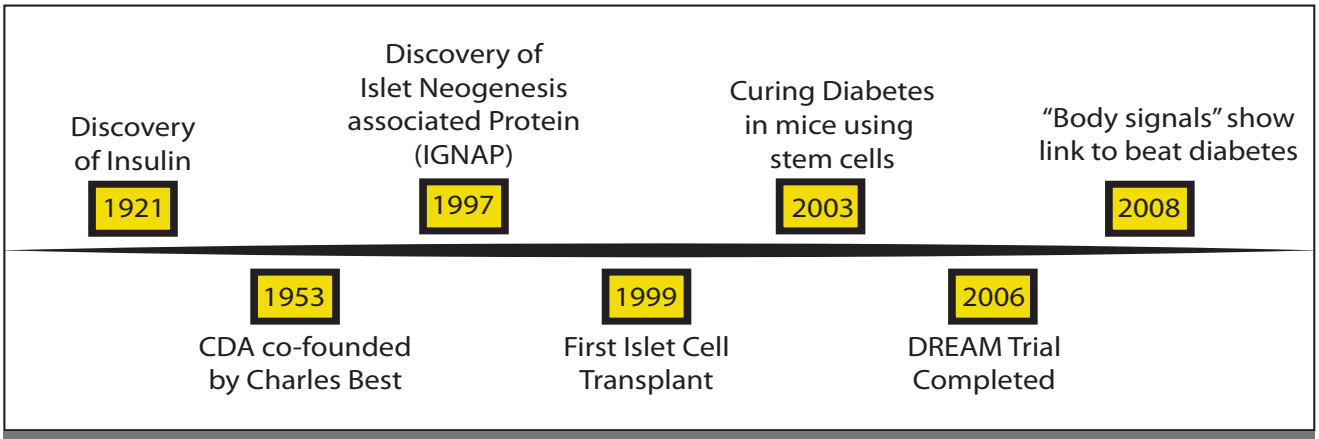
It's not a self-induced disease. People don't cause their own diabetes and you are not responsible for the diseases that you get; in the same way that you are not responsible for your lung cancer if we happen to live in a polluted environment. You are not responsible for radiation poisoning if you happen to live next to a leaky nuclear facility. People do not cause their diabetes, they do not cause their diseases, and it would be completely wrong to suggest so. The environment that we live in is a very 'diabetogenic' environment and induces the disease of the people who live within it. Our responsibility is to respond to the challenges of the day.

JT: How would you describe the support that Canada has put forth in terms of tackling the challenges of our day? Is there adequate support available to conduct the necessary research?

Diseases are international and the problem is international. Canadian researchers have a long, distinguished history in diabetes research in the past 100 years. The discovery of insulin [at the University of Toronto] is the most famous of these but also the first implementation of islet cell transplantations and the discovery of multiple other hormones/drugs were pioneered by Canadians. The history of success in Canada is large, ranging from the genetic level, therapeutic level and diagnosis advancements. Canada is blessed to have such a large number of researchers on this topic and that is fantastic. The funding environment for Canadian researchers is not optimal, but in fact, Canada consistently punches in well above its weight in terms of the world stage internationally, and the productivity is well above what is funded.

JT: Describe the coming together of the "DREAM team" and its main goals and visions.

At the time there were no clear ways to prevent diabetes. There were suggestions from the HOPE trial that other



Canadian researchers have a long distinguished history in diabetes research in the past 100 years.

drugs like the ACE inhibitors might prevent diabetes. The HOPE trial data suggested Ramipril might be preventing the outcome of diabetes. There was also interest in TZD drugs. The opportunity [for collaboration with renowned leaders in the field] arose and the proposal led to a consortium of funding from the Canadian Institutes of Health Research (CIHR) as well as by three different pharmaceutical companies in a beautiful example of industry-government collaboration, and the rest is history...

JT: What follow-up experiments have spawned from the DREAM trial results?

We are still interested in diabetes prevention and whether novel therapies reduce the risk of diabetes. The DREAM trial clearly showed that TZD drugs could reduce the risk of diabetes by 60% and we have led a number of studies investigating other treatment options such as the combination of TZD drugs with Metformin. In the past decade and over the course of around 9 trials, we have clearly shown that diabetes can be prevented. We weren't solely interested in the drug itself [rosiglitazone] but the class, the TZD class of drugs and their effect on [PPAR] gamma-activation that was promising. One [follow-up] study in particular is a large trial of 12,500 people with pre-diabetes or early diabetes and how the use of insulin can actually prevent cardiovascular problems, of which the results will be available in the next 8 months.

Dr. Gerstein then informs us that there is never a failed trial. Each study brings with it a set of new questions and new hypotheses that build upon previous results, a notion that forms the foundation of the scientific method. While the use of rosiglitazone has been met with recent controversy concerning potential cardiovascular toxicity, the TZD class as a whole remains of primary interest. And as mentioned, further studies that address these issues are underway and near completion. The DREAM trial showed us that type 2 diabetes can be prevented with an efficacy comparable to the gold standard of a complete life-style change, a feat not many drugs can claim to their name. It will certainly be interesting to compare results of other TZD chemical analogs to the efficacy of the commonly used rosiglitazone.

As Dr. Gerstein has reminded us, we Canadians are in good hands. It is clear that the maple leaf nation is at the forefront of scientific inquiry. Dr. Gerstein reminds us that "You can't look backwards to create the future and the only way to do that is to foster an environment that supports research. That is, empirical inquiry and investigation into what nature can and can't do. If our society ever abandons that, we are doomed, and we will drift away and die."

Jonathon Torchia

Jonathon Torchia completed both undergraduate and Master's biochemistry degrees at McMaster University before pursuing a PhD at the University of Toronto in the Department of Laboratory Medicine and Pathobiology (LMP). In his Master's work, he studied anti-cancer natural product biosynthesis from various bacteria, using next generation genome sequencing. In Jonathon's doctoral work, he will be extending his bioinformatics skills to study the genetics and molecular mechanisms of rare peadiatric brain tumors.

News Article

The Hidden Dangers of Obesity

Aida Sivro *(University of Manitoba)*
News Reporter (HSI 2011-2012)

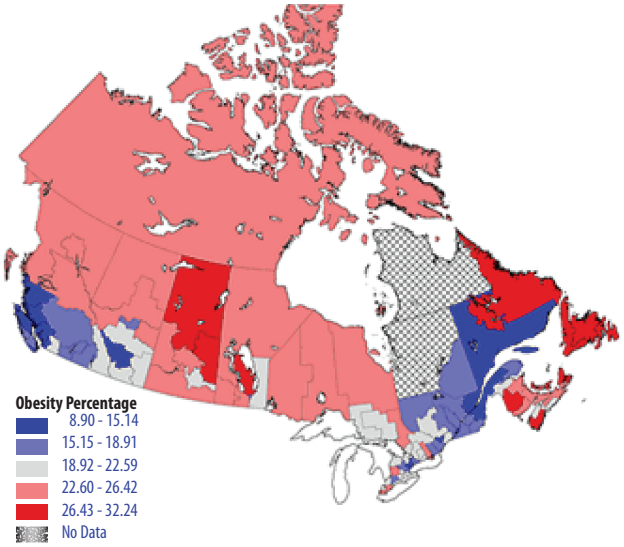
Obesity has become a world-wide epidemic. In Canada, approximately one in four individuals are obese. It is well known that being overweight increases the risk of developing numerous health problems and chronic diseases, including cardiovascular disease, cancer, and type 2 diabetes. However, research is increasingly demonstrating adverse effects of obesity on the immune system especially in the context of influenza infections.

During the 2009 H1N1 influenza pandemic, obesity was identified as a risk factor for influenza-related morbidity and mortality. Data from the United States demonstrated that obesity was disproportionately represented in hospitalizations, intensive care admissions, and deaths. In fact, people with a BMI (body mass index) > 45 had a 4.2 fold increase in the odds of death due to H1N1 independent of other risk factors. A similar study done at the University of Manitoba found that obesity was present in 33% of patients requiring intensive care admission. The reasons behind this

...people with a BMI (body mass index) > 45 had a 4.2 fold increased odds of death due to H1N1 independent of other risk factors.

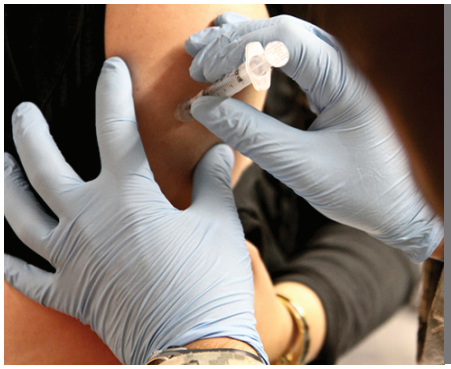
increase in morbidity and mortality due to influenza among obese individuals remain unknown. However, a number of factors have been theorized to contribute to the risk, including complications related to obesity in intensive care such as respiratory problems during general anaesthetic, the presence of obesity-related comorbidities such as diabetes, and the effects of obesity on the host immune response.[1,2]

An increase in visceral fat has been linked to the development of a low-grade systemic inflammatory state. Several studies performed in rodents have demonstrated that obese mice were more susceptible to morbidity and mortality due to influenza infection than normal mice as a result of changes in the innate immune response and the loss of function in influenza-specific immune cells.[3] Despite recent advances in understanding the immune changes linked to excess visceral fat, the complex role obesity plays in immune deregulation remains an unexplored area in humans.



Adult obesity (BMI ≥ 30) prevalence by health region, age and sex standardized to the 2005 Canadian population (25-64 years), Canadian Community Health Survey, 2005 *(Source: http://www.phac-aspc.gc.ca/publicat/cdic-mcbc/30-1/ar_01-eng.php) [1]*

Obesity also appears to impair vaccine-induced immune responses in humans.[4] In a study from the University of North Carolina, increased BMI was shown to be associated with a greater decline of protective antibodies over a 12-month period following influenza vaccination. In addition, impaired T-cell function, namely CD8+ T-cell activation and function, was observed in obese individuals compared to healthy controls. CD8+ T-cell responses specifically eliminate pathogens and protect against reinfection and are thought to be of paramount importance in the context of cross-protection against emerging new influenza strains. These findings suggest that obese individuals may remain susceptible to influenza infection even after vaccination. This is also consistent with previous research demonstrating a link between obesity and aberrant responses to tetanus



Obesity also appears to impair vaccine-induced immune responses in humans.

Source: http://healthystate.org/wp-content/uploads/2011/09/Flu-shot-pic.jpg

and hepatitis B vaccination.[5,6] Overall, these findings have important implications, as current vaccine strategies may be less effective in achieving herd immunity in an increasingly obese population.

The combination of increasing rates of obesity with the continuing threat of new pandemic influenza strains could prove to be a serious public health threat. BMI may serve as an important measure to identify individuals at high risk of severe influenza. More research is needed in order to characterize the interaction between obesity and the human immune response, with emphasis on improving CD8+ responses generated by vaccines. Such research has the potential to affect prevention and treatment of infectious diseases in the future.

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Aida Sivro

Aida Sivro is currently perusing a PhD in Medical Microbiology at the University of Manitoba. She is mainly interested in HIV immunology and the role host genetics plays in the susceptibility to HIV infection. Aida is also a trainee in the CIHR Infectious Diseases and Global Health Training Program (IID & GHTP)

News Article

The Regulation of Ghrelin Contributes to the Physiological Basis of Obesity

Susan Westfall *(McGill University)*
News Reporter (HSI 2011-2012)

A New Perspective on Obesity

Obesity is generally regarded as a disease of poor lifestyle habits. Albeit true, humans have an innate predisposition to obesity depending on several physiological characteristics. This physiological predisposition is supported by epidemiological evidence describing the susceptibility of individuals to obesity despite lifestyle choices. Today, the obesity epidemic is being described as both a lifestyle disease and a metabolic disorder created by the poor regulation of hormones including the regulator of appetite, the desire to have food, fat deposition, and levels of ghrelin.

The Regulation of Ghrelin

Ghrelin is a 28-amino acid stomach-derived hormone discovered in 1999 by a group in Japan.[1] Uniquely, ghrelin is the only hormone that responds to the amount of food in the digestive tract by increasing appetite, food intake and accumulation of body fat. If a negative energy balance occurs, such as during fasting, ghrelin secretion increases, leading to increased appetite and ability to store fat deposits.[2]

People with disrupted sleep schedules tend to gain weight, despite a normal caloric intake.

Ghrelin is regulated beyond its response to food. Even without food intake, ghrelin is rhythmically secreted from the stomach in a circadian manner.[3] Dr. Alfonso Abizaid, of Carleton University in Ottawa, investigated how ghrelin secretion is regulated by the circadian clock. Briefly, the circadian clock is the endogenous 24-hour molecular oscillator that integrates daily environmental signals such as the sleep-wake cycle, socialization habits, and feeding rhythms into a robust 24-hour cycling of molecular components. These fundamental oscillations synchronize physiological aspects in order to optimize the body's response to daily environmental changes. For example, it is known that people with disrupted sleep schedules tend to gain weight, despite normal caloric intake. This can be attributed to misaligned circadian rhythms created by differing sleep schedules. The perfect coordination of appetite, eating time and digestion is mediated through circadian oscillations of factors like ghrelin, cortisol and insulin. When these axes become misaligned, metabolic diseases, including obesity, are likely to manifest.

Ghrelin is the only hormone that responds to the amount of food in the digestive tract by increasing appetite, food intake and accumulation of body fat.

Ghrelin is not directly associated with energy balance alone. Stressful stimuli alter the normal circadian ghrelin release by increasing the desire to reach for energy-rich 'comfort foods'. This desire to eat high-energy foods (concentrated in simple sugars and fats) comes from the release of ghrelin, stimulation of dopaminergic neurons and the reward pathways which associate comfort with these foods.[2]

The mechanism of ghrelin action involves both peripheral signalling and important central neuronal signaling that controls the addictive and desirous nature of food consumption. Ghrelin acts directly on its receptors in the hypothalamic region of the brain stimulating the release of orexigenic peptides like neuropeptide Y (NPY). NPY then directly stimulates the desire for food as well as a sense of predictive reward towards consumption of energy-rich foods. This is the very same pathway that makes psychostimulatory drugs like amphetamine, cocaine and alcohol highly addictive.[4]

Ghrelin, like addictive drugs, releases dopamine into the ventral tegmental area of the brain increasing the anticipation of rewards and the insatiable desire to have increasing amounts of the stimulus. This addictive

phenotype explains the addictive nature of eating that many people suffering from obesity describe.[5] Interestingly, ghrelin might be the strongest modulator of dopamine release stimulated by feeding making interventions against its action not only beneficial for curbing obesity, but also the psychostimulatory effects of addictive drugs.

Prospective Treatments

The discovery of physiological factors like ghrelin in the regulation of obesity has given new perspectives into pharmaceutical treatments for obesity. Ghrelin is already being used to reduce appetite and fatty deposits and to control blood sugar. Conversely, ghrelin analogs are beings used to stimulate the appetite of persons suffering from wasting disorders or degenerative diseases.[2]

Interestingly, the treatment of circadian misalignment that would consequently stabilize ghrelin release is another treatment avenue for obesity in shift-workers. Melatonin is a chronobiological hormone that when given as a supplement to people working shift work helps stabilize their circadian rhythms. It has been found that melatonin also helps to stabilize ghrelin rhythms and consequently balance the energetic usage of food. Melatonin has already been shown to be beneficial in the treatment of irritable bowel syndrome, regulation of GI mobility and obesity.[6]

Conclusion

Obesity is a disease which not only reflects poor lifestyle choices, but is also a result of the misalignment of physiological factors, including hormones like ghrelin, that regulate energy balance. Genetics or physiology cannot be blamed for an obese state; however, genetics can impose a predisposition to obesity. This new angle of obesity research in the molecular condition provides novel and promising possibilities towards therapeutics that can help those suffering from obesity.

Acknowledgments

Special Thanks to Dr. Alfonso Abizaid for his contribution and insights on the above article.

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Susan Westfall

Susan's has recently completed her Master's Degree in the Integrated Program of Neuroscience from McGill Univerisity, Montreal. Her research focused on the interplay between the immune system and circadian regulation, the endogenous 24 h physiological rhythms. In addition to her interest in science, Susan recognizes the significance of alternative healing methods. Her focus now after the completion of her Master's, is to prove using the scientific dogma, that alternative health practices are reliable and should be incorporated into the western paradigm of health.

News Article

High Rates of Diabetes in Aboriginal Populations Demands a Complex Solution

Megan Dodd *(McMaster University)*
Managing Editor - News Articles (HSI 2011-2012)

The rate of type 2 diabetes for First Nations people living on reserve is three to five times higher than that of other Canadians.[1] Individuals of First Nations, Inuit and Métis heritage constitute the Aboriginal population in Canada. In the 1940s this disease was barely known, yet it has grown to become widespread in Aboriginal communities since then. The increasing rates have prompted the government of Canada to commit $275 million over the next five years for preventative programming.

Among Canadians with diabetes, between 90% and 95% are estimated to have type 2, while 5% to 10% have type 1, and 3% to 5% have a temporary form of gestational diabetes, which develops during pregnancy.[1] Type 2 diabetes is a metabolic disorder that is primarily attributed to changes in diet, decreased physical activity, and other factors that contribute to higher rates of obesity.

Diabetes was 17.2% among First Nations individuals living on-reserve, 10.3% among First Nations individuals living off-reserve, and 7.3% among Métis, compared to 5.0% in the non-Aboriginal population.

On December 15, 2011, the Public Health Agency of Canada released Diabetes in Canada: Facts and figures from a public health perspective.[2] This report provides the age-standardized rates of type 2 diabetes in Canadian populations. Statistics indicate that the prevalence of diabetes is 17.2% among First Nations individuals living on-reserve, 10.3% among First Nations individuals living off-reserve, and 7.3% among Métis, compared to 5.0% in the non-Aboriginal population. Although rates of diabetes in the Inuit population are comparable to the rest of Canada, risk factors of obesity, such as poor diet and physical inactivity are expected to cause an increase in the near future.

An educational poster created as part of the The Aboriginal Diabetes Initiative (ADI).

Amanda Lipinski, a Toronto area Diabetes Prevention Coordinator of the Southern Ontario Aboriginal Diabetes Initiative states, “Everyone knows someone with diabetes in the native community.” She adds, “Children as young as 5 are now affected, and you didn’t used to see that in the past.”

Lipinski states the main causes of the high rates of diabetes in the Aboriginal population are due to a loss of traditional culture, which includes food and medicines. “Now we eat lard, salt, sugar, flour, and milk, which are all foreign to native people. Our ancestors didn’t eat that… in short it is food that caused the problem – white processed foods.”

The problem is complicated by the isolation of many reserves where access to healthy food is limited. Processed foods are more accessible because they’re more affordable, “milk is more expensive than pop” Lipinski states, “there are no animals, and the cleared land is not suitable for planting”.

The Aboriginal Diabetes Initiative (ADI) was established by Health Canada in 1999 to “reduce the incidence of type 2 diabetes through a range of health promotion, prevention, screening and treatment services, delivered by trained health service providers and community diabetes

News Article

prevention workers". It had an initial funding of $58 million over five years, just over half of the total $115 million allocated for the Canadian Diabetes Strategy. This was later expanded in 2005 to a budget of $190 million over five years. In 2010, the budget committed $275 million over the following five years "for the ADI to continue supporting health promotion and diabetes prevention activities and services."

We need to "show people how to live healthy, not just hand out information.

Lipinski focuses on both the treatment and prevention of diabetes in the Aboriginal community in the Toronto area. Her job is to "promote holistic wellness in the community and provide them with the tools to make powerful healthy decisions". Health Canada states that "ADI reaches more than 600 Aboriginal communities across Canada".

Diabetes in the Aboriginal populations is a complex problem. According to their website, partners of the Canadian Diabetes Strategy believe that what is most needed at this time is a "concerted, long-term approach to prevention and control, one that engages the efforts of all who have a stake in the issue -- the many Canadians affected by diabetes, their families, health care providers, health care institutions and workplaces, governments, voluntary organizations, the non-health sector and the public at large".

Lipinski feels to reduce the rate of type 2 diabetes we need "less talk and more action". She says we need to "show people how to live healthy, not just hand out information... we need to provide them with hands-on tools". Some of these tools include kitchen courses, walking groups and fitness circles.

Lipinski sees the situation of the high prevalence of diabetes in Canada's Aboriginal population improving; "people want to know and are eager to learn".

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Megan Dodd

Megan Dodd has been a student of McMaster University for many years where she pursued a variety of academic interests. She is currently developing a gene therapy for hemophilia in the department of Biomedical Engineering as a PhD candidate. She has a strong interest in science communication and is a coordinator for the Hamilton Let's Talk Science site, and manager for the news section of Health Science Inquiry. She hopes to graduate soon and find a challenging and rewarding career in the field of biotechnology.

News Article

Canada's International Development Research Centre Launches Program to Fund Non Communicable Disease Prevention Research in Developing Countries

Janis Geary *(University of Alberta)*
News Reporter (HSI 2011-2012)

In July 2011, Canada's International Development Research Centre (IDRC) announced the launch of a program that will provide funding to research projects in low- and middle-income countries (LMICs) to assist in their fight against the rise in non-communicable diseases (NCDs). The program, called the Non-Communicable Disease Prevention program (NCDP), has been approved for an initial 5 years of funding (2011-2016). NCDP will target funding to academic researchers leading initiatives with the potential to generate local evidence for creating policies which are low cost but have a high impact on reducing the NCD burden through prevention. The NCDP is more than just a funding program, and funded researchers receive support to develop, implement, and compile evidence effectively.

The program responds to the rising burden of NCDs on developing countries. 63% of all deaths worldwide are attributable to NCDs, which have now replaced infectious diseases as the global leading cause of death.[1]. The World Health Organization (WHO) estimates that of the 9 million people who died prematurely from NCDs in 2008, 90%

Two thirds of all deaths worldwide are attributable to NCDs, which have now replaced infectious diseases as the global leading cause of death.

of those were in LMICs. According to the NCDP Program Leader, Greg Hallen, preventing NCDs is the key to reducing disease burden: "It's becoming clearer and clearer that the burden of NCD is already upon us and rapidly getting worse, and that no country, least of all low- and middle-income countries can afford to treat themselves out of it. It is a rapidly developing problem that cuts across all borders and requires the development of low cost, preventive solutions."

NCDs include cardiovascular diseases, diabetes, cancer, and

Tobacco use is one of the four common risk factors for development of non-communicable disease.

chronic obstructive respiratory diseases. They share four common risk factors of unhealthy diet, physical inactivity, tobacco use, and alcohol misuse. IDRC's NCDP will focus its research funding on policies which address these four common NCD risk factors, and cost-effective community-wide interventions that have potential to be scaled up to address the common risk factors in a broader population.

The high burden of morbidity and mortality due to NCDs in developing countries has an impact on development, which is the focus of organizations like IDRC. Hallen points out that it's not just the high number of deaths that are causing problems in LMICs: "Both morbidity and mortality impact development. People, especially in LMICs are dying earlier, in the productive years of their lives and being less productive due to chronic illnesses that require expensive or unaffordable treatments." The WHO predicts that in LMICs, NCDs will be responsible for the loss of three times as many productive years (due to disability or premature death) than communicable diseases by 2030.[2]

The NCDP isn't an entirely new concept but an extension of IDRC's successful Research for International Tobacco Control program (RITC). For over 15 years RITC has been providing funding and support to LMICs to address tobacco use. Although IDRC recognized the opportunity to apply their success in tobacco control to NCDs, it was critical for them to not lose this focus on tobacco control to credibly address all NCDs. One reason that the RITC was a large

News Article

The NCDP isn't an entirely new concept but an extension of IDRC's successful Research for International Tobacco Control program (RITC).

success was because IDRC approached tobacco use as a multi-sectorial issue. Hallen points out: "Most of the work to address NCDs has been in high-income countries, and most of that work has been done in the health sector. This, of all health problems requires a multi-sectoral response. Even if health services quickly do all they can to prevent NCDs, it would be useful, but by no means anywhere near what needs to be done by other sectors to address the risk factors for NCDs."

One area where RITC has experienced success is in supporting research on fiscal policies for tobacco control. Hallen says that "Fiscal policies can help to adjust the affordability and accessibility of different products and create a differential between healthy and less-healthy products, making the health products more affordable and accessible.". NCDP also aims to support research that balances health and commercial interests and to understand the potential rules of engagement with the food industry that may help to increase the accessibility and affordability of healthy foods.

One of the first steps taken by the NCDP after it was announced in July was to put out two calls for concept notes. While the program is open to receiving ideas and concept notes from researchers in LMICs at any time, this was an attempt to generate new interest in this research at the early stages of the new program. The calls were for policy related research on healthy diets and on fiscal

The WHO predicts that in LMICs, NCDs will be responsible for the loss of three times as many productive years (due to disability or premature death) than communicable diseases by 2030.

policies for tobacco control, and are open to applicants who are citizens or permanent residents of a LMIC and also have a primary work affiliation with a LMIC institution. The goal is to accelerate funding for research on low cost and cost-effective policies to increase the availability and consumption of healthy foods and to generate sustainable fiscal policies that reduce tobacco use. NCDP received almost 140 concept notes. "This high level of interest helps us to build a program of research around these issues and is an indicator for development agencies and funders of the increasing need for resources in this area."

To learn more about the NCDP, please visit the program website at: http://www.idrc.ca/EN/Programs/Global_Health_Policy/Non-Communicable_Disease_Prevention/Pages/default.aspx

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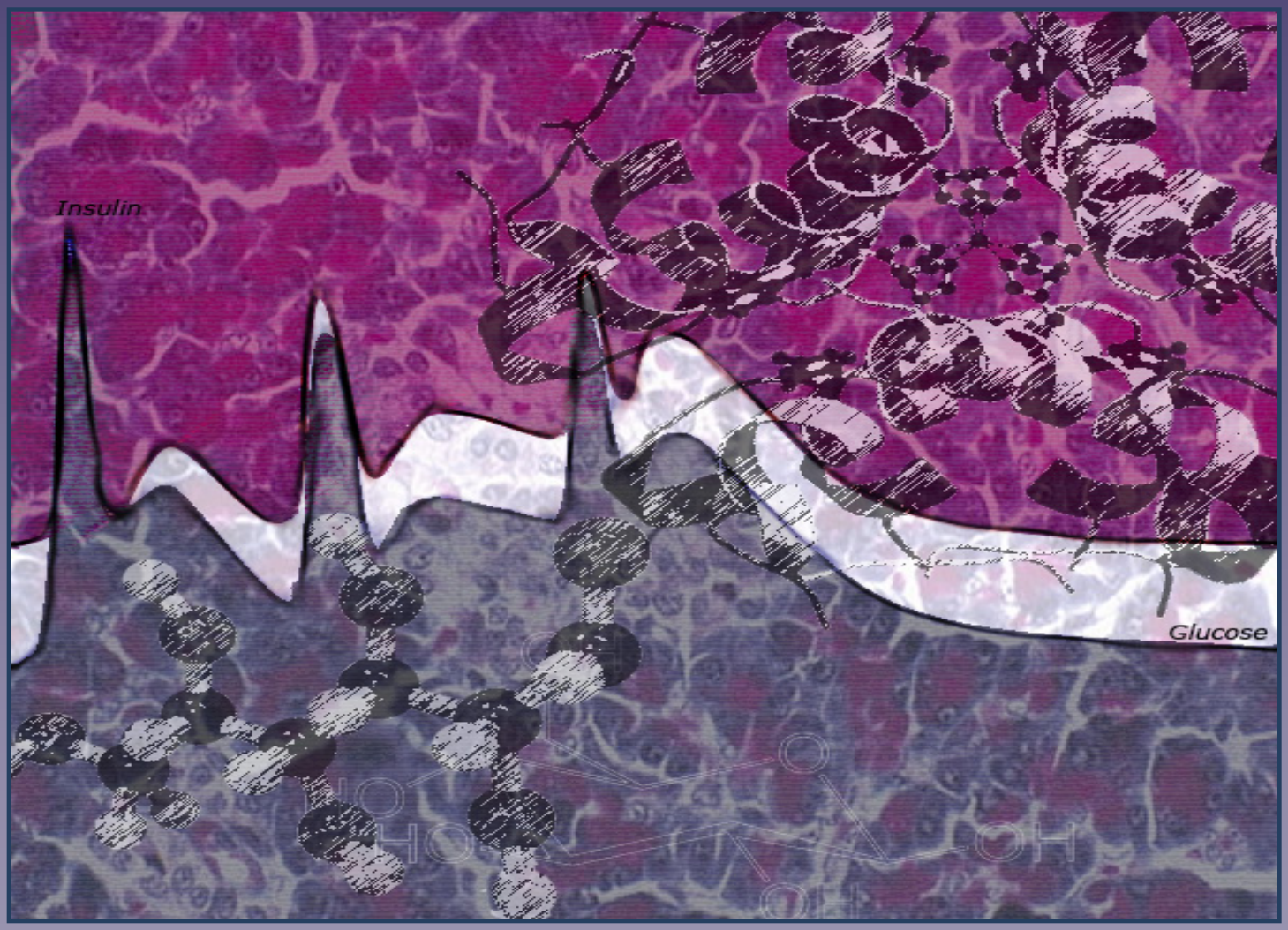
Janis Geary

Janis Geary is a 2nd year PhD student in the School of Public Health at the University of Alberta. After completing her undergraduate degree in Microbiology at the University of Manitoba, she moved to Edmonton to complete a Masters degree in Global Health. Since completing her masters she has been Project Manager for the Canadian North Helicobacter pylori Working Group. For her PhD, she is working on a project titled "Enhancing Trust and Communication in North-South Research Collaborations: A commons theoretical framework to equitable use and management of databases and biorepositories to support translational biomedical research".



SECTION 2: DIALOGUE PIECE

HSI invited an expert in the field of diabetes research to write a 1000-word essay on a controversial topic that would generate discussion amongst our staff members and general readership. This year, Dr. Prasad S. Dalvi has written a piece outlining the role that insulin may have on the brain in mediating obesity and diabetes.

HSI Editorial Team members were then asked to submit comments in response to this stimulating piece of writing. These responses were aimed at questioning and challenging the original author's viewpoints in a respectful manner.

The original author was then asked to submit a 500-word response to the comments written by the HSI Editorial Team.

Dialogue Piece

Original Dialogue Piece

Insulin action in the brain and how this may cause/exacerbate obesity or diabetes

Prasad S. Dalvi

The discovery and isolation of insulin by Banting, Best, Collip and McLeod at the University of Toronto 90 years ago was one of the greatest events in the history of medicine. Since then, insulin has become the life-saving therapy for insulin-deficient type 1 diabetes patients and also patients with advanced type 2 diabetes. Presently, the incidence of type 2 diabetes has increased dramatically, from an uncommon ailment a few centuries ago to a worldwide epidemic affecting 350 million people globally. As per data published by the WHO, worldwide, 90% of people with diabetes suffer from type 2 diabetes that is developed largely due to physical inactivity and excess body weight, or obesity. Thus, obesity has become a global health issue and, as such, has been recently termed by the WHO as 'globesity'. Obesity increases mortality risks due to related complications with the main one being type 2 diabetes.[1] In the fight against obesity, major efforts are currently underway to determine the central mechanisms involved in the regulation of complex processes such as appetite control and regulation of energy balance.

The main control centre of energy balance in the brain is the hypothalamus, which consists of neurons that integrate signals arriving from peripheral organs and other neurons of the nervous system to regulate appetite and maintain energy balance.[2] The hypothalamic neurons are subdivided into several nuclei that control many functions such as hunger, satiety, fluid balance, and glucose regulation. Within the arcuate nucleus (ARC) of the hypothalamus, appetite-stimulating neuropeptide Y (NPY) / agouti-related protein (AgRP) neurons promote an increase in food intake and a decrease in energy expenditure leading to the storage of energy in the form of fat. In contrast to the NPY/AgRP neurons, the pro-opimelanocortin (POMC) neurons of the hypothalamus release α-MSH, a major appetite-suppressing neuropeptide. When POMC neurons are stimulated, they promote a decrease in food intake and body weight.

Insulin is a key regulator of food intake and energy balance[3,4,5] and a major metabolic hormone that regulates glucose homeostasis in the body. Insulin's role is to facilitate transportation of the food-derived glucose to target organs, such as muscle, liver or fat and make it available as an energy source. In the periphery, insulin is secreted by pancreatic beta cells. At present, there is a growing interest in insulin action on the brain in the regulation of obesity and type 2 diabetes.[6] Insulin enters the brain and interacts with a number of key insulin receptor-expressing neurons in the hypothalamus that play crucial roles in the control of energy balance.[7,8] In contrast to insulin's peripheral anabolic actions that increase energy storage, the central actions are shown to be catabolic that cause reduction in food intake and body weight.[6] Recent research, however, suggests that there can be another side to the central insulin action, as some recent findings demonstrate that the central action of insulin may not necessarily be catabolic, but can be anabolic depending on the diet affecting peripheral insulin secretion. One study demonstrated a novel and previously unknown role for the central insulin when the peripheral insulin levels became higher than normal. When mice were exposed to a high-fat diet, the central insulin activated steroidogenic factor (SF)-1 neurons of the ventromedial nucleus in the hypothalamus and activated SF-1 neurons inhibited POMC neurons in the ARC, which resulted in suppressing the feeling of satiety and thereby increasing food consumption.[9] It is quite intriguing that when the insulin receptors were deleted or inactivated in the SF-1 neurons, the mice remained lean despite consumption of high-fat diet, while their counterparts with the functional insulin receptors on the SF-1 neurons rapidly became obese. This finding suggests that increased levels of insulin during high-fat diet conditions may indirectly inhibit POMC neurons via activation of SF-1 neurons. Future research may reveal that inhibition or deletion of the insulin receptor gene and subsequent inactivation of insulin action may

potentially provide partial protection from high-fat diet-induced hyperphagia, weight gain, and obesity.

Increased insulin levels that result from a high-fat diet have been demonstrated to decrease insulin sensitivity leading to insulin resistance in the hypothalamic neurons.[10,11,12] Further, high insulin levels can develop insulin resistance in the hypothalamic neurons that could contribute to the development of obesity.[13] (In this context, it must be noted that the hypothalamic obesity occurs due to insulin resistance caused by hyperinsulinemia).[14] In healthy humans, the consumption of a regular diet stimulates insulin to be released from the pancreas within the normal range. In contrast, a chronic high-fat diet causes excessive insulin release from the pancreas, exposing brain structures to high levels of insulin, and thereby causing insulin resistance in some neurons or over-activation of insulin receptors in other neurons. Both actions can disrupt insulin-mediated regulation of appetite and energy balance that may result in excessive food intake, surplus energy storage and obesity. This effect of exposure of hypothalamic regions to high levels of insulin could constitute an effective evolutionary adaptation by the brain to an irregular food supply and extended periods of hunger. During a period where an excess of food is available, the excessive insulin release could potentially lead to an increase in appetite and a reduction in calorie expenditure through temporary insulin resistance in appetite-suppressing neurons, such as POMC neurons, and overstimulation in neurons, such as SF-1neurons, that further inhibit POMC neurons. The end result was a surplus of energy reserves and weight gain that were necessary to sustain life in the periods of food deprivation. In the early human era, this evolutionarily-conserved mechanism was turned "on" and "off" depending on the availability of the food to properly regulate appetite and energy balance. However, it seems that during the present period of abundance in the developed world, this mechanism is constantly turned "on" leading to an increase in appetite and fat storage.

Overall, normal insulin actions in the brain are essential in the regulation of energy balance; however, excessive insulin exposure is harmful, as it may lead to obesity and further to type 2 diabetes. Thus, if a well-balanced and healthy diet is followed, the resulting normal levels of insulin are beneficial, but as soon as the insulin levels become excessive and chronically remain pathological, the brain triggers reserved mechanisms, such as inhibition of appetite-suppressing neurons, resulting in surplus of energy intake and storage that may ultimately lead to obesity or diabetes.

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Comment 1: On the role of brain insulin action for obesity and diabetes

This article is outlining the relationship between a high fat diet, resulting insulin action in the brain and the development of diet related chronic disease including obesity and diabetes. The author begins by describing the shocking statistics that reflect present day burden of obesity and highlights the World Health Organizations (WHO) recent use of the term 'globesity' to emphasize the global nature of the obesity epidemic. In fact obesity is not the only health related outcome claiming 'epidemic' status. Besides the global epidemic of obesity, the WHO also refers to the epidemic of diabetes, cardiovascular disease (i.e. heart attack and stroke) and cancer.[1]

In response to these epidemics, the author suggests that, '*major efforts are underway to determine the central mechanisms involved in the regulation of complex processes such as appetite control and energy homeostasis*'. This is an important dimension of understanding obesity and diabetes, however one could argue for other dimensions of the aetiology of chronic disease includes broader factors acting upon these aspects of human physiology. For example, the WHO also makes reference to the 'obesogenic environment', which is a term to describe the many dimensions of our 'modern environment' that encourage consumption and discourage expenditure.[2] It is characterized by plentiful access to cheap, energy dense, nutritionally deficient foods that appeal to our pocket books and taste preference for salty/fatty foods and our countless technological conveniences including cars, elevators and escalators to save us the trouble of expending precious calories.[3]

Although the environment was not discussed directly, the author acknowledged that our evolved physiological mechanisms for dealing with energy imbalance remains programmed for a world of scarcity and constant physical work. In my view this is a profound statement; one that leaves those of us interested in *how* we reverse these global epidemics, vigorously scratching our heads. From the perspective of human physiology within an evolutionary context, as described in this article, it seems that there are a few possible paths forward. One is to fundamentally change human physiology (i.e. insulin actions in the brain) to favour an environment of abundance; or begin system level intervention to do the necessary political, economic, social and cultural work needed to create more balance in our modern environments so our physiology is not overwhelmed by excess fatty diets, increased insulin in the body and resulting obesity and diabetes. There is, of course, one additional pathway. However, it is the pathway we have been stumbling down for the past three decades, the one that has left those of us in disease prevention frustrated and with ever increasing prevalence of global chronic disease. I am referring to the *behavioural* path. The author of this article alludes to it when the author states, '*To control the detrimental effects of excessive insulin the new mantra should be: low-fat food, less brain insulin, lean body, and longer healthy life*.' I would argue that this mantra has been given serious scientific exploration and testing over the past few decades, with modest and mixed results.[4] It is often called the Eat-Less-Move-More (ELMM) mantra and exclusively appeals to an individual's behaviour while simultaneously neglecting their physiology and the environment in which that physiology evolved. In practice a focus on isolated health behaviour can often result in not only failure to make behavioural changes but stigmatization of the individual seen as responsible for their own disease status.[5]

As a scientific community, we need research that explores the physiological processes as in this article. However, we must also be mindful of applying a behavioural solution to problems of primarily physiological and environmental origins.

Tarra L. Penney (HSI Senior Editor)

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Comment 2: On the role of brain insulin action for obesity and diabetes

While I agree with the overall sentiment of Dr. Dalvi that obesity can lead to impaired insulin signaling in the brain, he only touches on the positive role that insulin plays in maintenance of a lean body composition. Before I expand on insulin's role as a satiety signal and vital glucostatic regulator, I would like to highlight its evolutionary importance.

Insulin has been shown to play an important role in regulating life span, growth, and reproduction, as well as energy homeostasis in organisms as primitive as Caenorhabitis elegans (roundworm) and Drosophila melanogaster (fruitfly).[1,2,3] Furthermore, it has been shown that humans share the same conserved molecular mechanism of insulin signaling used by these simple organisms.[4] With that said, what positive roles does insulin have within the brain that have allowed it to stay relatively unchanged throughout many organisms and years of natural selection. Firstly, as mentioned in Dr. Dalvi's piece, insulin can act as a satiety signal, making individuals feel full after eating a meal. It is hypothesized that insulin's direct induction of the appetite supressing α-Melanocyte-stimulating hormone (α-MSH) release from POMC neurons and suppression of the orexogenic neuropeptide Y (NPY) release from NPY neurons causes suppression of feeding behavior.[5,6] Insulin has been shown to regulate glucose homeostasis centrally by altering hepatic glucose production (HGP). Infusion of insulin to the brain has been shown to substantially decrease hepatic glucose output in mice.[7] Furthermore, in mice lacking the insulin receptor (IR) within the feeding-related agouti-related protein (AgRP) neurons in the hypothalamus, the effect of central administration of insulin is attenuated.[8] In whole body IR knockout mice that have IR restored specifically within AgRP neurons, infusion of insulin once again suppresses HGP.[9] This finding suggests that not only does insulin play an important role in regulation of glucose within the periphery, but can exert effects within the brain to regulate peripheral tissue glucose utilization.

In 2010, Paranjape et al. proposed another mechanism by which insulin regulates peripheral tissue glucose utilization, this time by regulating release of glucagon (the hormone responsible for decreasing glucose uptake in the periphery). This group found that glucose acts centrally within a subset of ventromedial hypothalamic neurons to regulate glucagon secretion within the pancreas in both hypoglycemic and normal conditions.[10] Taken together, these findings suggest that the role of insulin in the brain is to fine-tune the ability of peripheral tissues to uptake glucose, thereby increasing the energy available to these neurons. By decreasing hepatic glucose production, insulin increases energy stores in the form of glycogen to be used in times of metabolic stress. The decrease in glucagon secretion further decreases the amount of glucose expelled from peripheral tissues into the blood, further increasing total body glucose uptake. In a normal individual, following a meal, insulin secreted by the pancreas is sensed within the brain. Signals are then sent which modify feeding behavior via NPY/POMC thereby decreasing the craving to eat.

The evolutionarily conserved mechanism of insulin action is in place to keep our bodies healthy and lean, and only after severe damage or chronic abuse from sugary foods and drinks does this highly ordered system malfunction. It is important to acknowledge everything that insulin does to keep our body in balance. Collectively, the vital role that insulin plays centrally in energy balance and homeostasis has made it an evolutionarily conserved component of our homeostatic system.

Sean A. McFadden (HSI Managing Editor)

Sean A. McFadden is a Master's graduate student in the area of diabetes research and neuroendocrinology at the University of Toronto.

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Dialogue Piece

Author's Response to Comments

I would like to thank Mr. Sean Mcfadden and Ms. Tarra L. Penney for their thoughtful responses to my article and for raising a number of valid points. I will address the responses of each in sequence and clarify my points of view further.

Mr. Mcfadden notes quite rightly that I did not address many beneficial insulin actions that are mediated via central nervous system to regulate peripheral glucose levels. Rather, I presented the relatively unknown actions of the excessive insulin in the brain that may contribute to development of obesity. I particularly focused on that aspect, because it is the disruption of the normal insulin signaling that leads to type 2 diabetes.

It is now known that the insulin and insulin signaling pathways are evolutionarily well conserved among multicellular organisms, including both vertebrates and invertebrates.[1] Apart from insulin's role as a major regulator of intracellular and blood glucose levels, it plays a pivotal role in cellular developmental processes such as growth and aging.[1] Although all these functions are evolutionarily very well conserved across almost all species, unlike humans, most multicellular organisms are infrequently exposed to high sugar and therefore high insulin levels. Thus, these organisms may never suffer from the detrimental effects of pathological levels of insulin. Recently, it was found that altered insulin signaling resulting from brain insulin resistance may play a major role in the pathogenesis of neurodegenerative diseases, such as Alzheimer's disease.[2] There are several factors, such as toxic lipids, that may cause impairment in brain insulin signaling and lead to neuronal death. Therefore, it is tempting to speculate that increased brain insulin levels also contribute to neurodegeneration via insulin resistance.

In agreement with Mr. Mcfadden's response, the satiety action of brain insulin must not be ignored. Investigations have shown that insulin and a fat cell-derived satiety hormone leptin send signals, known as adiposity signals, to the brain about peripheral energy status. However, the signaling function of these hormones remains intact until their respective levels are within physiological limits. Once the levels become supra-physiological or pathological, neurons develop resistance to both hormones and the brain stops receiving the signals about the energy stores in the body. The absence of adiposity signals may cause the brain to perceive that there is a constant energy deficit that further causes the brain to trigger appetite-stimulating NPY/AgRP neurons to induce excess energy intake and surplus fat storage. This can be exemplified by increased appetite and fat mass in obese individuals, most of whom have leptin and insulin resistance. As insulin resistance is developed in humans who consume high-glucose or high-fat diet, it is no wonder why wild animals remain immune to obesity and therefore insulin resistance and all deleterious effects associated with it.

Mr. Mcfadden mentions about the role of brain insulin in glucose regulation by its action on liver. There is no doubt that insulin and glucagon are potent regulators of glucose metabolism mainly acting on liver. Although both exert counter-regulatory actions on each other, during embryonic stage, the cells that generate these hormones arise from a common precursor cell.[3,4] This suggests that evolutionarily these hormones are closely related. It is the glucagon that is 100-fold active than insulin during embryogenesis.[3] This indicates that glucagon, the hormone that increases glucose levels in the blood, predominates over insulin at the initial development of an embryo. But as the embryo grows and gradually the glucose levels increase in the organism, insulin levels start rising to regulate the glucose utilization and counter-regulate glucagon action. Insulin's direct action on muscle and liver, and its indirect regulation via brain to increase glucose uptake by peripheral organs are necessary to prevent harmful effects of high glucose levels. However, with the development of peripheral and brain insulin resistance, insulin's counter-regulatory action on glucagon is impaired, leading to a marked increase in liver glucose output and break-down of fat to increase fatty acid levels. Eventually, this may lead to metabolic crisis such as diabetic coma. Thus, for healthy life it is imperative to maintain optimal insulin levels at all times.

Ms. Tarra L. Penney reminds us that the world is facing not only obesity epidemic, but also epidemics of several other diseases, such as cardiovascular diseases and cancer. Unfortunately, gathered epidemiological data suggest that a major contributor of all these diseases and metabolic disorders is the excessive fat mass and obesity. Indeed, I agree with Ms. Penney that we live in 'obesogenic environment' in the developed world. Absolutely, it is hard to make healthy choices among multiple unhealthy life-style choices that surround us in the "modern Western environment". The evolutionarily-conserved mechanisms that were triggered rarely or intermittently are constantly turned on and are reset to cope with this environment of

Author's Response: *Insulin action in the brain...*

abundance in such a way that is not beneficial to human health. For example, recently, it was found that total sperm count was significantly negatively correlated with body mass index in young adults and sperm quality was compromised in obese individuals.[5,6]

Ms. Penney suggests two ways to deal with these global epidemics. As mentioned in her response, one way is to fundamentally change human physiology rather than to change an environment of abundance. At present, pharmacological manipulations to prevent brain insulin resistance in humans are far from our reach. As mentioned earlier, insulin is evolutionarily well conserved, and I wonder about its function and overall fate over the next hundreds or thousands of years, if human brains continue to be exposed to high insulin levels.

Ms. Penney further points out the failures of the Eat-Less-Move-More (ELMM) mantra in the combat against obesity and diabetes. As obesity is a complex issue involving both physiological and environmental factors, she recommends focusing on the broader social and enviornmental factors. Although this option may demand a lot of resources at a population health level, it is quite feasible if strong government and public initiative support are sought. Finally, I feel that only proper education, counselling based on scientific findings, and constant motivation to fight against obesity will bring some hope.

Prasad S. Dalvi

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Prasad S. Dalvi, MD, PhD (Candidate)

Prasad Dalvi is currently a PhD student enrolled in the Department of Physiology, University of Toronto. He completed his medical training at Donetsk State Medical University, Ukraine (former USSR) and worked as a family physician in rural India for several years. He is currently completing a doctoral dissertation on the hypothalamic mechanisms involved in appetite regulation at the University of Toronto. His research interests include metabolic disorders such as obesity and diabetes.

SECTION 3: MAIN SUBMISSIONS

Call for Submissions

Back in November of 2011, graduate students from all across Canada were asked to submit commentaries on various aspects of obesity and diabetes. The commentaries were 700-800 words in length (maximum of 10 references) and focused on one of three specified topics of interest:

- ***Molecular, Genetic and Clinical Research in Obesity and Diabetes***
- ***A Sociological View of Obesity and Diabetes***
- ***The Impact of Nutrition on Obesity and Diabetes***

Review / Revisions

Starting in March, each submission was reviewed by 2-3 different Reviewers from HSI. Reviewers provided feedback to the authors by critically assessing the content and writing of each commentary. After receiving comments from Reviewers, authors were given 2 weeks to revise their submission and resubmit their manuscript to the journal. A team of Senior Editors was then given the task of going through each commentary and providing final comments.

Judging Process

Faculty members from Canadian universities (see Page #) were recruited as advisors, playing an instrumental role in the judging process of the journal. For each of the above three categories, 4 faculty advisors were assigned to rank each of the submissions in order of preference. A score was then assigned to each paper depending on how it was collectively ranked by all faculty members:

Example: Rank #1: Paper 1C = 5 Points
Rank #2: Paper 1A = 4 Points
Rank #3: Paper 1D = 3 Points

Section 3: Main Submissions

Winners

After processing the rankings from all our faculty advisors, a combined score was tabulated for each submission. The authors of the highest scoring paper for each category received a free 1-year subscription to The International Journal of Obesity. In addition, one of the papers was granted expedited review for possible publication in The International Journal of Obesity.

The quality and creativeness of all the submissions were outstanding, and both the editorial team and faculty advisors highly commend the authors for their achievement and hard work! After tabulating the results, we are pleased to announce the winning submissions for the 2012 issue of Health Science Inquiry. Each of the authors have received a free 1-year subscription to The Canadian Medical Association Journal, and one submission will be granted expedited review and possibly publication in a subsequent issue of the journal.

Molecular, Genetic and Clinical Research in Obesity and Diabetes

Marc Bomhof *(Page 70)*

Gut Bugs, Energy Balance, and Obesity

The Impact of Nutrition on Obesity and Diabetes

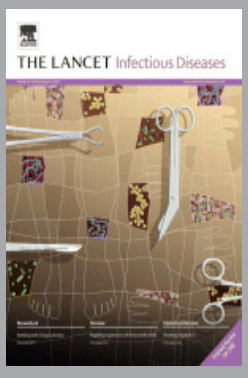
Jane Polsky *(Page 84)*

The continuing epidemics of diet-related disease: environmental drivers of the modern diet and why governments must get involved

A Sociological View on Obesity and Diabetes

Denise Darmawikarta *(Page 100)*

Nipping it in the bud: the role of primary care in early prevention and management of childhood obesity



Past Winners

Chelsea Himsworth's paper was published as a 'Reflection and Reaction' piece in a 2010 issue of **The Lancet**: **http://www.thelancet.com/journals/laninf/article/PIIS1473-3099%2810%2970148-1/fulltext**

Timothy W. Buckland's paper was published as a 'Salon' piece in a 2011 issue of **The Canadian Medical Association Journal**: **http://www.cmaj.ca/content/early/2011/10/11/cmaj.111419.long**

JUDGING PANEL

We are very fortunate to have the involvement of 9 distinguished faculty members from all across Canada for this issue of Health Science Inquiry. Each faculty advisor was assigned to one of the three categories students were asked to write commentaries on, and their main responsibilities were to judge and comment on the submissions within each category.

Kristi Adamo, MSc, PhD

Dr. Kristi Adamo earned her MSc in physiology from the University of Guelph, Department of Human Biology and Nutritional Science and her PhD in cellular and molecular medicine from the University of Ottawa, Faculty of Medicine. She is currently a Research Scientist with the Healthy Active Living and Obesity Research group at the Children's Hospital of Eastern Ontario Research Institute and an Assistant Professor in Human Kinetics and the Department of Paediatrics at the University of Ottawa. Her research program Power of Prevention in the Early Years, focuses on early lifestyleher research team explores the applicability of healthy active living intervention strategies during key phases of growth, development and determination of long term health (intrauterine, preschool, elementary school and adolescence).

Khosrow Adeli, PhD, FCACB, DABCC, FACB

Dr. Khosrow Adeli obtained his Ph.D. and M.Sc. in Biochemistry from the University of Ottawa and subsequently completed a postdoctoral fellowship in Clinical Biochemistry at the University of Toronto. Dr. Adeli is currently head and full Professor of Clinical Biochemistry at the Hospital for Sick Children and the Departments of Biochemistry, and Laboratory Medicine & Pathobiology at the University of Toronto in Toronto, Canada. He is also the Director of Point of Care Testing program at the Hospital for Sick Children in Toronto.

Stephanie Atkinson, PhD

Dr. Stephanie Atkinson is Professor and Associate Chair, Research, for the Department of Pediatrics at McMaster University. She is also an Associate Member of the Department of Biochemistry and Biomedical Sciences, and serves as Special Professional Staff in McMaster Children's Hospital. Current professional activities include serving as Chair of the Institute Advisory Board for the Institute of Human Development, Child and Youth Health of the Canadian Institutes of Health Research (CIHR) and McMaster Centre Leader & Executive member for the Canadian Child Health Clinician Scientist Program - a strategic research training program funded by CIHR. Dr. Atkinson is also Vice-chair of the Board of Directors of the Maternal, Infant, Child and Youth Research Network (MICYRN) and co-leads the Canadian Birth Cohort Research Network initiative within MICYRN.

Section 3: Main Submissions

JUDGING PANEL

Rachel Colley, PhD, BPHE, BSc

Dr. Rachel Colley is one of two researchers selected as the inaugural Healthy Active Living and Obesity Research Group (HALO) Junior Research Chairs; funded by the CHEO Foundation and The Lawson Foundation. Dr. Rachel Colley completed her PhD in Brisbane, Australia in 2007 at the Queensland University of Technology and joined the HALO team in August 2007 as a post-doctoral research fellow. To the HALO research group, she brings experience in applied exercise physiology with specific skills in the measurement of physical activity, sedentary behaviour and body composition. Dr. Colley is currently the Scientific Officer for Active Healthy Kids Canada and led the research and writing of the 2008, 2009 and 2010 Report Cards on Physical Activity for Children and Youth. She is a part-time research analyst focused on the accelerometry data from the Canadian Health Measures Survey at Statistics Canada. She has recently completed a study investigating the influence and interplay of fitness, motor skills, activity preferences and self-efficacy on physical activity engagement in healthy weight and overweight children.

Dean Eurich, MSc, PhD

Dr. Eurich's area of interest is in clinical epidemiology and natural history of disease and patterns of health service delivery. Within those core areas, he has also been involved in research aimed at the optimal use of evidence based treatments and practice/policy improvement. Dr. Eurich is a member of the Alliance for Canadian Health Outcomes Research in Diabetes (ACHORD) which is a multidisciplinary (i.e. medicine, epidemiology, pharmacy, economics and health policy) and multi-sectorial (i.e. government and academia) collaboration of researchers in diabetes research, in Canada and internationally that aims to establish evidence-based policy relevant research.

Katherine Gray-Donald, PhD

Dr Gray-Donald is involved in studies of the nutritional health of different high risk populations in Canada and abroad. These high risk groups currently under study are children at elevated risk of obesity and the elderly. Dr Gray-Donald is interested in understanding the lifestyle related causes of childhood obesity and the metabolic consequences of obesity in children. This research is being conducted within a large cohort study at the Hopital Ste Justine. In addition Dr Gray-Donald is studying interventions directed towards healthy lifestyles through both environmental changes, such as the food offered in school settings in Quebec, developing and evaluating intervention programs and in the Kahnawake Schools' Diabetes Prevention Project.

JUDGING PANEL

Candace Nykiforuk, MA, PhD

Dr. Candace Nykiforuk is a health geographer and health promotion researcher with expertise in program and policy research at community and provincial levels. Broadly, she is interested in examining the role of built and social environments in the development and success of program and policy changes to support health and well-being. Candace leads the Place Research Lab, which undertakes work in the areas of community health and the environment, prevention of cancer and other chronic diseases, healthy aging, tobacco control, obesity and program evaluation. Candace's research has involved youth, adult and senior populations in multiple settings (e.g., schools and communities).

Laura Rosella, MHSc, PhD

Dr. Laura Rosella is a Scientist at Public Health Ontario, an Assistant Professor at the Dalla Lana School of Public Health in the Division of Epidemiology and an Adjunct Scientist at the Institute for Clinical Evaluative Sciences. Her research is focused on population risk tools and public health intervention assessment as applied to obesity and diabetes. In addition, she is interested in the integration of scientific evidence and tools into public health decision-making. She teaches graduate courses at the Dalla Lana School of Public Health in the areas of Epidemiology and applied Biostatistics.

Gregory Steinberg, PhD

Dr. Steinberg obtained his PhD in 2002 from the University of Guelph. His research thesis was conducted in the laboratory of Professor David Dyck where he studied the regulation of metabolism in muscle by the hormone leptin. From 2002-2006, Dr. Steinberg conducted Postdoctoral Research in the laboratory of Professor Bruce Kemp at St. Vincent's Institute of Medical Research in Melbourne, Australia. During this time he gained insight into protein biochemistry and molecular biology with an emphasis on the metabolic stress sensing protein kinase AMPK. In 2006, Dr. Steinberg became Head of the Metabolism Unit at St. Vincent's Institute of Medical Research and a Senior Fellow of the National Health and Medical Research Council of Australia. In 2009, Dr. Steinberg returned to Canada and joined the Department of Medicine, Endocrinology and Metabolism Division as an Associate Professor and Canada Research Chair. His laboratory is currently funded by grants from CFI, CIHR, CDA and NSERC.

Main Submission

Physical education: Preventative health care for youths

Alexandra Stoddart

University of Western Ontario

Obesity is at an epidemic level in this country. In recent years, the trend towards obesity has increased with 26 percent of women overweight in 2000, compared to 14 percent in 1985.[1] Forty percent of men were overweight in 2000, upwards from 22 percent in 1985.[1]. Physical inactivity is also costing Canada massive amounts of money; in 2000 it was reported that about $2.1 billion of the total health care costs in Canada were attributable to physical inactivity.[2] Seventy percent of adolescents with obesity will grow up to become obese adults, and they will have more severe obesity than those who become obese in adulthood.[3] With the notable increases in both obesity and diabetes, physical education (PE) should be strongly advocated for youths in order to diminish these obesity trends.

Current Canadian physical activity guidelines recommend that children accumulate a daily minimum of 60 minutes of moderate to vigorous physical activity (PA).[4] Additionally, it is recommended that all children have at least 150 minutes of curricular instruction in PE per week.[5] This is wherein the problem lies. While some provinces have introduced mandatory daily PA, no province has educational policies mandating daily PE, and PE is rarely a requirement for grades 10-12.[5] In many cases, PE is the only opportunity for children to be active throughout the day.

Various associations, such as the Canadian Medical Association, recommend daily, quality PE in kindergarten through grade 12 because physical inactivity is such a strong contributor to being overweight.[5] Reducing sedentary behaviours to less than 2 hours a day is critical for increasing PA and for increasing good health6. There is extensive evidence that PA decreases the risk of cardiovascular disease, regulates blood pressure, lowers the risk of certain cancers and diabetes, and is beneficial for arthritis.[2,5,7] PA has beneficial mental health effects as well. Current research suggests that bouts of PA facilitate children's performance on tests that measure attention, memory, rapid decision making, and planning.[8] Simultaneously, low aerobic fitness and obesity in children are associated with poorer academic performance.[8] Research has demonstrated that high quality PE programs result in vast improvements in physical fitness levels and an enhanced academic performance.

A high quality PE program allows students to be active for the entirety of the class, build a fundamental skill base, and participate in interactive ways. Unlike the old gym class that was focused on team sports and dodge ball, now children can learn multiple ways to exercise that will be relevant throughout their lifetime. For schools that have the funds, the use of heart rate monitors can help students become aware of how their bodies respond to exercise.[9] Interactive games like Dance Dance Revolution have been successful in raising daily PA levels, as well as increasing exercise motivation and adherence.[7] With these types of exergaming programs, individuals are more likely to exercise for fun instead of focusing on losing weight.[7] As children age, this will become especially critical as enjoyment remains one of the main factors of adherence.[7] Health report cards have also been used as an aid in obesity prevention. Parents who received health and fitness reports were almost twice as likely to acknowledge that their child was actually overweight compared to those who did not get a report card.[3] Additionally, the parents who received the health report cards were over twice as likely to plan weight control activities for their children.[3] In addition to changes within the PE curriculum, PA can be integrated into academic subjects.[10] Using a multidisciplinary approach (e.g. combining geography and PE), students can be active for a greater portion of the day.[10] Aside from the health benefits that daily PA provides, it also contributes to instilling lifelong healthy values. By introducing PA early in life, it allows children to value and live an active lifestyle instead of a sedentary one, thus altering the obesity trends evident today.

At the most basic level, physical education is an active form of health care. Rapidly growing literature continues to link physical inactivity with obesity and diabetes. Prevalence of obesity in children is increasing at a rapid rate. Children should be the prime group targeted for obesity intervention strategies because almost all children are accessible in schools.[5] For those who are making decisions about education curriculum at the present time, it should be clear that physical education is a vital component of all schooling, regardless of age. In order to change the rising trend of obesity, Canadians need to be proactive instead of reactive. Obesity is a problem that will not simply go away; physical education has the potential to positively impact this predicament.

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Alexandra Stoddart

Alexandra Stoddart is currently pursuing her MA in Kinesiology at the University of Western Ontario. She received her BSc and PE teaching certification from Eastern Michigan University. Her main research interests include motor learning and cognitive inhibition.

Main Submission

Genomics and young populations: Unlocking the door to preventative medicine

Angie Karlos and Dustin Hittel

University of Calgary

On a population level, rapidly rising obesity rates have been attributed to physical inactivity and the consumption of calorie dense foods. Obesity and its associated co-morbidities, such as type 2 diabetes (T2D) and cardiovascular disease (CVD), decrease quality of life and result in an estimated 35 million premature deaths annually.[1,2] Despite extensive efforts to understand the pathophysiology of obesity and develop efficacious prevention, treatment, and management strategies, obesity rates continue to increase. A major challenge to understanding the etiology of obesity is the significant inter-individual variation in both susceptibility to and consequences of this disease. However, the development of genome-wide association studies (GWAS) has provided a novel method that can be used to investigate and explain many inter-individual differences in chronic diseases.

GWAS involve conducting unbiased genome-wide scans of thousands of subjects to identify common variants, or single nucleotide polymorphisms (SNPs), associated with a trait or disease of interest.[3] GWAS, which require no *a priori* knowledge of biochemical mechanisms and pathways, can therefore lead to the discovery of novel genetic variants, and provide new insight into the pathophysiology of chronic diseases and continuous traits. Despite the successes of these studies, a major criticism of GWAS are their small effect sizes, whereby only a small percentage of the variation of each trait is accounted for by the SNPs identified by this method. This is particularly the case when compared to estimates of the contribution of genetic factors to a trait from family studies, in which traits that are similar between siblings are considered to be predominantly genetic in nature.[4] For example, while a recently published GWAS identified 95 loci that were significantly associated with variability in lipid concentrations, these loci accounted for only ~25-30% of the genetic variance in each lipid trait (TG, TC, LDL and HDL).[5] In contrast, these traits were estimated to have ~50-70% variability in family studies.[6] The disparity in the levels of variance detected by GWAS compared to the estimated genetic contribution to those traits from family studies is a major obstacle to the clinical utility of GWAS. Therefore, a great amount of emphasis has been placed on determining whether an imperfect understanding of allelic architecture and/or SNP interactions with the environment, other genes, or age cause this "missing heritability".

The accumulation of environmental exposures such as physical inactivity or poor diet may cause an increase in the variability of complex traits and diseases, making genetic associations more difficult to detect.[4] It has therefore been hypothesized that investigating genetic associations in young, healthy populations will yield larger effect sizes than are observed in older, symptomatic populations. More importantly, different genes may be involved at different stages of disease pathogenesis, and the identification of those associated with early, developmental stages may provide valuable targets with the potential to predict future disease risk. In addition, interventions developed to target genes involved in the *development* of, rather than the *perpetuation* of disease could lead to primary prevention.

GWAS investigating polygenic contributions to CVD have consistently found three SNPs on chromosome 1p13, in close proximity to the SORT1 gene, to be significantly associated with LDL and risk of CVD. In these studies, the minor, or less frequent, alleles were associated with LDL concentrations 0.1-0.2 mmol/L lower than those of the major alleles, as well as with a 9-13% decreased risk of developing CVD.[7,8,9] Interestingly, smaller validation studies have shown that the 1p13.3 locus accounts for a much larger proportion of the variability in LDL in younger, asymptomatic subjects than in older, symptomatic subjects (2.5-4.1% versus 1%, respectively).[10] The larger effect of this variant in younger populations is significant, as it provides evidence of a gene-age interaction that accounts for some

of the missing heritability in the 1p13-LDL relationship.

The field of genomic medicine is in its infancy; however, it is growing quickly as technology advances to meet the increasing demand for more efficient and cost-effective sequencing. While GWAS have successfully identified a large number of loci associated with chronic diseases in older populations, the evaluation of these associations in younger populations may provide better insight into disease etiology, as well as discover potentially valuable targets for disease prevention. Genetic risk stratification in children may prove to be a more valuable screening method for disease risk than measures such as insulin for T2D and LDL for CVD. Furthermore, in diseases that do not have an intermediate measure, such as obesity, genotype has the potential to be an extremely valuable indicator of disease risk that could be used early in life for disease prevention. Identifying genetic loci associated with the development of disease pathophysiology at a young age, as well as elucidating the mechanisms underlying these pathologies, will result in advancements in the prevention and treatment of complex diseases such as T2D and CVD.

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Main Submission

PPARγ ligands: Is timing the key to therapeutic vs. obesogenic effects?

Graham Skelhorne-Gross

Queen's University

Obesity and several diseases associated with obesity have become epidemic in Western society, including type II diabetes, cardiovascular disease and hypertension. To prevent future cases and develop effective therapies for existing patients, researchers have worked to understand the etiology of obesity. The pervasive axiom has been that obesity is caused by prolonged imbalances between energy intake and output.[1] Simply put, obese individuals eat too much and do not exercise enough. However, recent evidence suggests that, like most diseases, the development of obesity may involve numerous genetic and environmental risk factors that interact in complex ways. At the cellular level, obese individuals have more, and much larger, adipocytes (fat cells) than the rest of the population. This basic biology is problematic for proponents of the energy-imbalance theory, because adipocyte number is established by early adulthood,[2] often before over eating habits and sedentary-lifestyles take effect. Therefore, obesity in adulthood may result from predisposing factors rather than recent lifestyle decisions.

Several theories have been postulated to explain obesity predisposition, including single nucleotide polymorphisms in multiple genes, viral infections, chronic stress and sleep reduction. More recently, a group of chemicals known as obesogens have emerged as factors that may contribute to a predisposition to obesity. Obesogen researchers believe that exposure to certain environmental chemicals can cause obesity by altering adipocyte tissue biology. Significantly, the effects of these chemicals are postulated to be independent of the classic modifiable risk factors: diet and exercise. At present, a PubMed search for "obesogens" only garners 19 papers; however, the significance of chemical exposures that drive obesity should not be understated. Obesogens, including diethylstilbestrol, bispehnol A, phthalates and organothins, alter normal lipid hemostasis by targeting nuclear receptors that govern adipocyte differentiation, resulting in the accumulation of lipids and adipogenesis.[3] The obesogen theory is especially intriguing, because one of the nuclear receptors targeted by these chemicals is the peroxisome proliferator-activated receptor (PPAR)γ, a receptor that confers a protective effect in multiple diseases.[4]

Drugs in the thiazolidinedione (TZD) class, which target PPARγ, have been used for years to treat obesity-associated diseases such as type II diabetes and atherosclerosis. TZDs enhance adipocyte differentiation, resulting in an increase in the proportion of smaller, mature adipocytes within adipose tissue. This is of significance, as larger, immature adipocytes produce more of the proinflammatory cytokines that, together with fatty acids, are thought to be responsible for the development of insulin resistance.[5]

Emerging evidence also suggests that TZDs may have a promising role in the treatment and management of several types of cancer, another disease for which obesity is a risk factor.[6] Specifically, PPARγ ligands have been shown to reduce tumour burden by decreasing cell proliferation and inducing differentiation, phenotypic changes that are desirable compared to the cytotoxic effects of most current chemotherapeutics. Indeed, the inclusion of PPARγ ligands in chemotherapy regimens has been shown to decrease the doses of traditional cytotoxic agents required for positive effects and, in some cases, has allowed cells to overcome resistance to them.[7]

Despite these successes in diabetes and cancer, PPARγ ligands are not without their pitfalls. Studies have shown that prolonged use of PPARγ activators leads to edema and weight gain,[8] which is consistent with the well-established notion that PPARγ activators are adipogenic.[9] The therapeutic versus harmful effects of PPARγ activation therefore need to be carefully assessed, given the potential for PPARγ ligands to reduce morbidity and mortality due

to cancer, diabetes and other diseases. This is especially important since hundreds of thousands of individuals worldwide use TZDs as front-line therapy for type II diabetes, not to mention the fact that PPARγ activators, such as some fatty acids, are present in foods.[4]

Further research should be performed to clarify the specific mechanisms by which obesogens activate PPARγ and whether the dose or age of exposure is most relevant to their effects. The obesogen theory, which states that adipogenic chemicals alter adipocyte numbers in adolescence, implies that exposures later in life are not as harmful. This means that there may be a critical time period in which PPARγ activators act as obesogens and exert harmful effects. This is significant, because if the obesogen theory holds true, PPARγ activating drugs should not be used to treat children and pregnant women. In this model, neonatal through pre-teen obesogen exposure could increase the number of an individual's adipocytes, making them susceptible to obesity throughout their lives. It would be unfortunate if it turns out definitively that PPARγ activation is harmful to young people, as prophylactic treatment with PPARγ activators has shown protective effects in a number of diseases, including malignant breast cancer.[10] Given the prevalence of obesogens in the environment, eliminating exposure does not seem possible. Therefore, a thorough understanding of how they exert harmful effects is critical to reducing obesogen-driven morbidity in our population.

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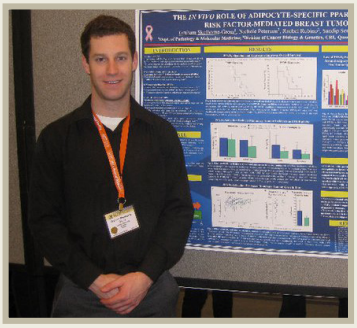

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Main Submission

What can clinical neuropsychology offer type II diabetes mellitus treatment management?

Michelle C. E. Monette

University of Windsor

In Canada, more than 9 million people have diabetes or pre-diabetes, with Type II Diabetes Mellitus (T2DM) accounting for the vast majority of diabetes cases.[1] Individuals with diabetes have a 1.2 to 2.3 times greater risk for Alzheimer's disease and a 2.2 to 3.4 times greater risk for vascular dementia than non-diabetics.[2] Further, it has been estimated that 7 to 13% of all cases of dementia can be directly attributed to diabetes.[3] Proper diabetes treatment and management may, therefore, contribute to a reduction in risk of dementia in T2DM. For example, Cosway et al.[4] demonstrated that individuals with well-managed diabetes did not significantly differ from non-diabetic controls in their cognitive functioning.

Unfortunately, diabetes treatment and management regimens are often complex and cognitively demanding. As such, many individuals with T2DM cannot effectively manage their treatment regimens, leading to poor treatment adherence.[3] Incorporating neuropsychological assessment and intervention strategies into T2DM management could alleviate the burden of cognitively-demanding treatment regimens, potentially resulting in a decreased risk of cognitive deficits and dementia and improved quality of life in this population. Integrated neuropsychological assessments could also facilitate identification of individuals who may present with cognitive decline indicative of early dementia.[2,5] Incidence of dementia begins to increase in the sixth decade of life;[2] thus assessments of cognitive functioning in individuals with diabetes would ideally commence at age 60.

Within the context of the individual's psychological, interpersonal, and environmental milieu,[6] neuropsychological assessment involves testing cognitive functions to determine an individual's cognitive strengths and weaknesses (i.e., their cognitive profile). The most crucial cognitive functions needed for effective diabetes management are memory and executive functions, which could be measured using the Wechsler Memory Scale IV and the Delis-Kaplan Executive Function System.[6] Yet these functions also represent the most common and severe cognitive impairments in individuals with T2DM.[3,7] A recent longitudinal study found significant differences between those with T2DM and non-diabetic controls on measures of processing speed, attention, and executive functions at baseline and at follow-up four years later.[8]

Individuals with low-average or borderline skills in these cognitive domains could benefit from specific strategies that could be implemented to make diabetes management more feasible. For example, for individuals with poor prospective memory who do not remember to take their medication or insulin, reminders could be implemented that would work best with their lifestyles, such as an alarm on a phone or a note in a day planner. For individuals with poor planning and time-management skills, structured strategies for meal planning could be implemented to ensure that they adhere to their dietary restrictions, which is often the most difficult aspect of diabetes management for those affected. Similar cognitive and behavioural memory-related strategies have been successfully implemented with individuals with amnestic mild cognitive impairment, resulting in increased independence in daily activities in these individuals.[9]

In addition to addressing specific weaknesses in cognitive functioning, psychological factors, such as perceptions of self-efficacy or anxiety and depression, could be addressed, along with implementing specific strategies that minimize the cognitive demands of treatment adherence. Social supports could be maximized and small changes in the environment could also be made to minimize the cognitive demands. It is well known that individuals with cognitive deficits benefit from structured environments.[10] Neuropsychologists have the necessary training and skills to implement these and similar strategies. They could work alongside diabetes program educators, families and, ideally,

in conjunction with the Canadian Diabetes Association to ensure this type of integrated care is systematically provided to all individuals with diabetes.

Incorporating neuropsychological assessment of cognitive functioning in the treatment regimens of individuals with T2DM, as has been advocated, will serve two goals. First, individuals with cognitive deficits who are at risk of developing dementia could be identified early before these deficits impact their diabetes management. Implementing the above strategies may also reduce the risk of further cognitive decline and dementia among persons with T2DM, thus minimizing the cost burden on the health care system. Second, it could also serve the broader goal of individually tailoring diabetes treatment regimens to the cognitive strengths and weaknesses of the individual, while taking into consideration psychological, interpersonal, and environmental factors that influence diabetes treatment adherence. Doing this would make diabetes treatment regimens more manageable and could improve treatment adherence and quality of life in individuals with T2DM.

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Michelle Monette

Michelle Monette is completing her PhD in Clinical Psychology in the Neuropsychology track at the University of Windsor. Her research focuses on improving diabetes management by simplifying and individually tailoring treatment regimens to improve glucose levels and quality of life in individuals with diabetes. She is also researching the risk factors for cognitive decline and development of dementia in individuals with diabetes and how best to lessen the risk for cognitive decline and dementia in these individuals.

Main Submission

Obesity and pain sensitivity: Why should we care?

Rebecca Price

McGill University

The global rise in the prevalence of obesity has, perhaps not surprisingly, led to an increase in the number of surgical procedures performed in the morbidly obese. Gastric bypass surgery in particular has steadily increased in frequency since the early 1990s, reaching a plateau in 2004 with an average of 113,000 surgeries performed per year in the U.S.[1] Respiratory depression due to perioperatively-administered opioids is a potential serious complication of this surgery for the morbidly obese patient.[2] Obesity is associated with concomitant respiratory dysfunction, particularly obstructive sleep apnea,[2] placing obese patients at a higher risk for opioid-induced respiratory depression than non-obese patients.

Interestingly, previous literature suggests that obese persons demonstrate decreased pain sensitivity.[3,4,5] However, this association is far from conclusive, as increased pain sensitivity[6] has also been observed. Nevertheless, if true, decreased doses of opioid analgesics may be sufficient to treat post-surgical pain in obese patients and so reduce their risk of postoperative respiratory depression. Moreover, the mechanism by which pain sensitivity is decreased in obesity could provide new insights into pain perception relevant for both obese and non-obese individuals.

Still, it is difficult to draw definitive conclusions regarding the role of pain sensitivity in obesity due to the methodological flaws of previous studies. For instance, only study samples with wide age ranges (where age was not controlled) [3,4,5,6] and composed predominantly of female volunteers[3,4] have been examined – despite the fact that both age and gender influence pain perception. In addition, previous studies did not account for the amount of local adiposity at sites used for pain testing (i.e. forearm).[3,4,5,6] As such, any differences in pain sensitivity observed between obese and normal weight participants could be due to local factors affected by adiposity (e.g., the local chemical environment) rather than central, systemic contributions, minimizing the ability to draw conclusions regarding generalized alterations of pain sensitivity. Other methodological weaknesses of previous studies include pain tests that were poorly described[5] or that lacked operational definitions of pain outcome measures.[3,4,6] In pain studies that rely on subjective pain measurements, it is crucial that study subjects be given specific standardized instructions to avoid inconsistencies in pain assessment that may lead to invalid findings.

The true relationship between obesity and pain sensitivity, therefore, remains unclear. Future rigorous studies that address the limitations of the current literature are needed to definitively conclude if pain sensitivity is altered in obesity. Despite this uncertainty, I propose that obesity is more likely to be associated with decreased pain sensitivity due to underlying relationships with reward processing[7,8] and inflammation.[9] So how could these relationships decrease pain sensitivity in obesity and why should we care?

Obesity may be the result of an addictive disorder in which patients are addicted not to drugs or alcohol, but to food. Much recent literature suggests that pain and reward are but two ends of the same spectrum, linked by neurotransmitters that have rewarding, as well as analgesic properties, including opioids8. Opioid agonists, such as morphine, are well-known effective modulators of pain, as well as appetite stimulants.[3,4,6] Obesity is already known to be associated with increased levels of beta-endorphin[e.g.7], an endogenous opioid agonist. This suggests that obese individuals may be chronically rewarded, shifted toward the hedonic and away from the pain end of the spectrum and leading to overeating, as well as decreased pain perception.

Obesity is also a state of chronic inflammation in which cytokines, both pro-inflammatory cytokines, which increase pain sensitivity, as well as anti-inflammatory cytokines, are secreted directly from the adipose tissue and are systemically

elevated compared to normal weight individuals.[9] Moreover, it appears that secretion of anti-inflammatory markers may be greater than pro-inflammatory cytokines in obesity as is the case of interleukin-1beta and its pro-inflammatory counterpart interleukin-1.[9] Recent literature in the pain field, particularly in inflammatory disorders, suggests it may be the ratio of pro- to anti-inflammatory markers that is clinically important.[10] Hence, a decreased ratio may underlie decreased pain sensitivity in obesity.

Certainly, there may be other potential explanations for decreased pain sensitivity in obesity — perhaps related to excess adiposity and/or chronic overeating. Should future studies indeed demonstrate the presence of decreased pain sensitivity in obesity, we would have a unique human model for research that would allow us to answer clinically relevant questions, including investigating the interaction between pain and reward. Understanding decreased pain sensitivity in obesity also has the potential to uncover novel pharmaceutical targets for pain management. While we already know obesity is associated with elevated levels of a class of molecules that are the most effective analgesics currently available, perhaps other mechanisms or molecules contribute to decreased pain sensitivity in obesity. This could provide new avenues for pharmaceutical research, as well as a basis for safer dosing procedures of post-operative analgesics in the morbidly obese.

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Rebecca is currently pursuing a master's in neuroscience at McGill University. Her primary research interest is in the modulation of pain perception through cognitive processes such as reward and mood and their influence on other biological systems. She plans on continuing these pursuits in the doctoral program at McGill.

Main Submission

Environmental pollutants and a potential strategy to reduce the risk of diabetes

Lee Grenon

Simon Fraser University

The increasing prevalence of type 2 diabetes mellitus (T2DM) throughout the world is often attributed to changes in diet and a more sedentary lifestyle.[1] Are there other potential underlying causes of this current pandemic? Environmental pollutants, particularly persistent organic pollutants (POPs), have been suggested by some researchers as potential contributors to the rising prevalence of diabetes as endocrine disruptors.[2] POPs include organochlorine pesticides (i.e., DDT), polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (i.e., common flame retardant compounds). These toxins are resilient to degradation in the environment and organisms.[3] In this article I briefly review evidence indicating an association between POPs and T2DM, and the potential implications for public health strategies to reduce the potential risks of T2DM.

Early evidence of an association between POPs and diabetes emerged from epidemiological studies of occupational exposure, and industrial and consumer product contamination.[2] Concerns for the environment and human health led to the establishment of the Stockholm Convention on Persistent Organic Pollutants to end the production and use of specific POPs in the participating nations.[3] Despite being banned in many countries, POPs are still present in the physical environment and our food chain.[3] POPs bind with lipids in animal adipose, organs and muscle.[3] The relatively long half-life of POPs which are resilient to metabolic degradation leads to bioaccumulation in plants and animals.[3] This bioaccumulation of POPs in fatty fish such as salmon and tuna, and in dairy and meat livestock, is the major exposure source for most people.[3]

Studies of the US population using the National Health, Nutrition and Examination Survey (NHANES) have found increased serum levels of POPs are associated with greater insulin resistance among non-diabetics and increased odds of type 2 diabetes.[4,5] Two recent animal studies have provided important insights into the possible biological pathway through which POPs may contribute to insulin resistance and obesity.[6,7] Ibrahim and colleagues recently reported that protein kinase B (PKB) phosphorylation is suppressed by exposure to POPs.[6] Protein kinase B is a well conserved signaling pathway across a diverse range of species[8] and important for many metabolic functions. It is particularly important for insulin signaling in a variety of target tissues including adipose, muscle, liver and pancreas.[8] The insulin-stimulated PKB phosphorylation is integral for increasing glucose transport into adipocytes and muscle cells.

The epidemiological evidence has not reported consistent findings on an association between POPs and diabetes.[2] However, the experimental studies provide a biologically plausible hypothesis that POPs in tissue suppress PKB phosphorylation. Further research is needed to determine with greater certainty the nature and extent of the association between the exposure to POPs and the increase in the risk of insulin resistance and type 2 diabetes in human populations. A better assessment of the risk is necessary for weighing the benefits and costs of strategies to mitigate the exposure to POPs.

However, we could propose a variety of strategies to mitigate exposure to these pollutants by applying the precautionary principle. This approach aims to prevent public exposure to a plausible risk even when there is not scientific consensus on the extent or potential of harm. However, the potential unintended consequences of such strategies need to be carefully considered. One strategy could focus on reducing dietary exposure among humans. For example, dietary recommendations to replace consumption of fatty fish and marine mammals with leaner species may reduce exposure to POPs.[6] However, such a strategy needs to be carefully discussed and considered in terms of the assessed risks among all stakeholders

since these fisheries are an important protein source for populations throughout the world. As an example, the maintenance of local food harvest practices in Inuit and First Nations communities is important for supporting healthy diet choices, improving economic self-sufficiency and cultural continuity.[9,10] Broad generic food advisories concerning pollutant contamination of fish and animals have generated anxiety and a loss of trust in local foods for some communities.[10] Well intentioned warnings to reduce exposure to POPs and other pollutants in fish may have the unintended consequence of increased anxiety over local food safety in general. The loss of trust in local foods can lead to decreased local food harvesting practices resulting in increased consumption of processed products high in carbohydrates, sugar and salt, greater reliance on food systems outside the communities and decreased culturally appropriate land-use practices.[9,10] A reduction in local food harvesting may have significant consequences for the physical activity levels and cultural practices of people in these communities already experiencing relatively high prevalence of both obesity and diabetes.[9,10]

Further research to assess specific risks associated with exposure to POPs is necessary to inform the development of effective strategies for reducing the risks of diabetes. These various dimensions of evidence suggest it is necessary to directly engage communities and groups most affected by these types of public health strategies to ensure optimized benefits and reduced costs for all communities.

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Main Submission

Pediatric obesity interventions: Are we targeting the right behaviour to impact obesity?

Emily Knight

University of Western Ontario

One quarter of Canadian children are overweight or obese,[1] a situation that poses serious consequences for Canada's health care system, both now and in the future. The World Health Organization estimates that 500,000 deaths in North America and Western Europe result from obesity and related diseases, and considers suboptimal weight status (i.e., overweight and obesity) to be among the greatest health challenges and risk factors for disease in the twenty-first century.[2] In Canada, the economic cost of obesity and physical inactivity is estimated to be $9.6 billion annually, which is nearly 5% of Canadian health care costs.[3] Physical inactivity is a preventable risk factor for many obesity-related chronic and non-communicable diseases, including diabetes.[4,5] Therefore, promoting healthy physical activity (PA) behaviours, particularly early in life, represents a substantial opportunity for chronic disease prevention, health care cost savings, and improved quality of life.[2]

Regular participation in moderate and vigorous intensity PA is associated with important physical, cognitive and emotional benefits, including musculoskeletal development, maintenance of healthy body weights, prevention of high blood pressure, and social and mental development.[6] Therefore, healthy PA behaviours have implications for children's psychological, sociological, and physiological health and development.[7] According to Canadian physical activity guidelines,[8], children and youth should accumulate at least 60 minutes of moderate to vigorous PA daily to accrue health benefits. However, directly measured data (via accelerometer) on a nationally representative sample of Canadian children indicate that merely 9% of boys and 4% of girls are meeting this target.[9] Furthermore, it has been demonstrated that physical fitness behaviours track from childhood into adulthood,[7] suggesting that the fitness of today's children is likely a reflection of future fitness behaviours, and corresponding health status, of the Canadian adult population. The bad news is that today's children are less fit than children were just a generation ago,[1] which has significant implications for public health in the years to come. To improve the health of future generations, the current obesity and PA crisis should be addressed. Based on the current state of the literature, the purpose of this commentary is to discuss how PA has been employed as a strategy in pediatric obesity interventions and to present ideas for better targeting PA behaviours in future interventions to reduce obesity.

PA is defined as any activity that involves bodily movement and results in energy expenditure.[10] Therefore the PA spectrum encompasses a range of activities children can engage in on a daily basis (Figure 1) – inactivity, such as sleeping; sedentary activity, such as reading or playing computer games; light activity, such as playing with toys; and moderate and vigorous intensity activities, such as playing tag in the schoolyard, skateboarding or swimming. When measuring children's engagement in daily PA behaviours it is important to consider the range of activities that children can participate in and the associated health benefits or consequences of these activities. Yet interventions for obese children and adolescents typically only attempt to increase and measure the time spent engaged in moderate and vigorous PA, which is only one end of the daily PA spectrum. This narrow focus may be contributing to the limited success that has been realized through typical obesity interventions designed for children and adolescents.[5,11,12,13] Obesity and PA interventions to date have been plagued by high dropout rates[11] and have been shown to be ineffective, resulting in no change or even undesirable changes in PA participation and/or body composition.[13] Interventions to date have perhaps missed an opportunity to observe changes in PA behaviours and obesity status by limiting their PA measurement to only moderate and vigorous PA.

Indeed, it has been suggested in the literature that targeting a

Figure 1: The continuum of daily physical activities ranges from inactivity through sedentary, light, moderate and vigorous intensity PA. On a daily basis children might engage in sports, games or active play that fall anywhere along the PA spectrum.

reduction in time spent engaged in lower intensity activities, instead of increasing time spent engaged in moderate and vigorous PA, may be a more effective approach to changing both PA behaviours as well as obesity status.[5,14] Given that the average Canadian child spends 62% of their waking hours engaged in sedentary behaviours and less than 8% of their day participating in high-intensity PA,[9] reducing time spent engaged in sedentary pursuits represents a substantial opportunity for changing PA behaviour through obesity interventions. For example, substituting sedentary activities in children's daily routines (such as being driven to school or sitting for extensive periods of time at a computer) with light intensity activities (such as walking to school or standing periodically while using the computer) may be a more effective way to change PA behaviours and impact obesity. It may not be reasonable to expect that a child or adolescent who currently spends the majority of their daily routine engaged in sedentary pursuits will immediately run or swim or engage in similar high-intensity activities. Therefore, interventions may achieve greater success in reducing obesity and increasing PA behaviours if they are designed to target and measure the range of PA intensities children engage in on a daily basis.

In summary, literature available from pediatric obesity interventions employing a PA component indicates that these interventions typically target and measure changes in total moderate and vigorous PA. However, future research should consider the entire spectrum of PA behaviours that children can engage in on a daily basis when designing and implementing PA-based pediatric obesity interventions. Findings from such studies may provide insight for future health promotion strategies to prevent or change obesity and develop healthy PA behaviours among Canadian children.

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Emily Knight

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Main Submission

Leveraging feedback: A systems approach to successful behaviour change in weight management

Penny Deck

Simon Fraser University

Approximately one in four Canadian adults are obese, a number that has doubled during the past 30 years.[1] The increasing prevalence represents both a health and economic burden and highlights the need for novel approaches to address obesity. Over the past decade there has been a shift in the academic literature to acknowledge obesity as a complex problem. Embracing the complexity of obesity opens the door for new strategies for solving the obesity epidemic, yet few pursue these opportunities. Solving complex problems requires a systems approach. Feedback, a process that allows a system to alter its behaviour or functions in order to achieve a desired outcome, is an important defining characteristic of complex systems. Although feedback loops provide potential for developing new solution strategies, they remain a poorly understood and under-utilized leverage point for intervention.[2] One area that will benefit from an improved understanding of feedback is individual health behaviour change. Feedback can be leveraged to both help assess the effectiveness of current interventions as well as to facilitate the development of new tools to assist in weight management.

A feedback loop is the basic operating unit of a system.[3] A simple generic feedback loop is illustrated in Figure 1. Information about the system's state is compared with a desired goal, forming a closed chain of connections that allows for decisions to alter behaviour that will change the actual state. Feedback loops may either reduce the occurrence of a behaviour or promote more of it (Figure 2). For example, consider a sedentary individual who wishes to become more active. However, when exercising, he feels uncomfortable and worries that others are staring at him. This discomfort serves as feedback which may decrease the frequency of exercising or stop the behaviour completely. An example of a reinforcing feedback loop is the cycle of binge eating. Consider an individual who eats because she is unhappy. Eating more may cause greater unhappiness; this in turn, may lead to more overeating, again leading to even more unhappiness, a vicious and repetitive cycle. Feedback here reinforces the behaviour, enhancing an established pattern, which, in this case, potentially contributes to weight gain.

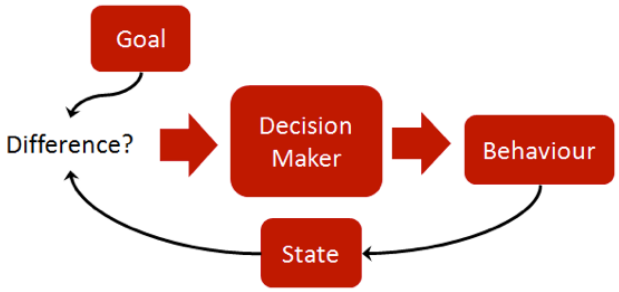

Figure 1: A Generic Feedback Loop

In order for interventions that leverage feedback to be effective, the feedback itself must be successful. Successful feedback elicits change within the system, is self-determined, and is able to evolve and adapt to changing conditions.[4] Determining if feedback does produce a change in the system may be challenging. For some feedback loops, there may be a long time delay before change occurs. For example, an individual trying to lose weight by reducing energy intake typically does not see an immediate decrease in body weight. Interventions supporting individual behavioural change by creating new feedback loops may be more effective if there is a shorter time period between initiating a change in behaviour and the response that feeds back into the decision making process. Furthermore, the relevance of feedback must be self-determined in order to motivate a change in behaviour.[4] Only the individual can identify what is important enough to act as a trigger. Sources of motivation vary with the individual, perhaps resulting from a life-threatening heart attack, having

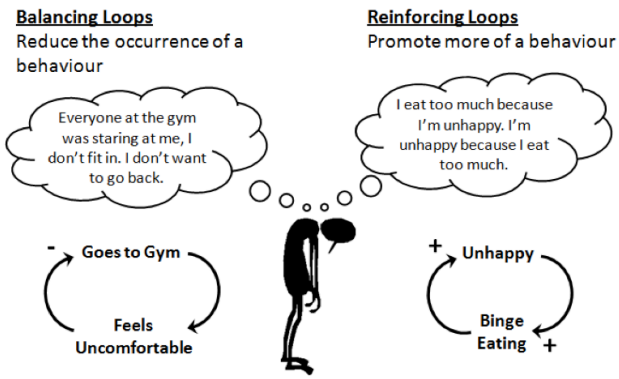

Figure 2: Balancing vs. Reinforcing Feedback Loops

children, or the break-up of a long-term relationship.[5] In addition, adaptability ensures that feedback is still effective despite changes in the system. For example, parents tend to assess the healthfulness of their own child's weight based on a comparison to other children. This in turn, may affect parents' decisions to seek help for their children. Research from the UK suggests that the body weight perceived as healthy and acceptable by parents is increasing.[6] This illustrates how a change in the system (e.g. increasing weight norms) requires adaptability (e.g. parents modifying their perceptions of what is healthy) in order to ensure they seek help when appropriate. Applying an understanding of these characteristics may be beneficial in ensuring the success of interventions based on feedback.

The effectiveness of feedback is also influenced by whether the feedback is based on the outcome of the behaviour or the process by which the outcome is changed.[7] Outcome based feedback provides information about the end result. For an individual with the goal of losing weight, the outcome measure is body weight as it changes over time. Outcome feedback exhibits longer delays; it takes time for a change in body weight to occur. To lose weight, the individual must either change dietary intake or physical activity levels to produce a change, both of which change weight indirectly. The longer delays increase risk of oscillations[3] such as that seen with weight cycling (a repeating cycle of weight loss followed by weight gain) which may lead to increased difficulty with additional weight loss attempts.

Process based feedback provides information about action, or the behaviour itself. In the weight loss example, one possible feedback strategy would be using a pedometer to track daily steps taken. As the feedback is about the behaviour itself, there are minimal time delays. Because the information is received more quickly and is specific to walking rather than weight, it is possible to modify the behaviour directly, such as making a decision to add more walking to the day's activities. Consequently, process based feedback may offer greater potential for success as it minimizes delays and allows for direct adaptation.

This understanding of feedback from a systems perspective offers a new framework for approaches to solving the obesity epidemic. Self-monitoring is an important component of behavioural weight loss strategies, yet success of such programs remains mixed, with adherence cited as a common problem.[8] Applying this knowledge about feedback may help construct improved tools for self-monitoring. For example, mobile technologies that facilitate tracking of behaviours[9] can be better designed to leverage feedback loops to support behaviour change at the individual level. Strategies that support self-determination by allowing individuals to identify what is most relevant to their specific situation,[10] that can be modified over time and in response to changing circumstances, and that focus on process rather than outcomes, promise to improve the success of the intervention. Feedback loops represent a gap in intervention strategies[2] and this framework will help identify the means to improve existing feedback loops as well as create new ones, adding an important tool to the arsenal of strategies used to combat the current obesity epidemic.

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Penny Deck

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Main Submission

Can active school transport prevent overweight and obesity in children and youth?

Richard Larouche and Travis J. Saunders

University of Ottawa

Several studies have shown that children and youth who engage in active school transport (AST)[i] accumulate greater amounts of daily physical activity and have superior cardiovascular fitness than those who are driven to school.[1,2] Not surprisingly, this has led some to wonder whether increasing AST (which is very low among young Canadians, especially adolescents)[3] may prevent overweight and obesity in pediatric populations. However, the most recent systematic review on the topic, including papers published up to December 2009, identified only two longitudinal studies with inconsistent findings.[2] Thus, the available evidence remains inconclusive. The current commentary aims to provide an overview of prospective studies published since this systematic review and to summarize important gaps in current knowledge.

A recent intervention study assessed the impact of walking school buses[ii] on indicators of body composition among elementary school children over a two year period.[4] After adjusting for age and gender, frequent walkers (defined as participants who walked ≥ 50% of the time) had significantly smaller increases in body mass index (BMI), waist circumference, and skinfold thickness than "infrequent" walkers and passive travelers.

Other studies have also shown positive associations between AST and body weight. Participants from the Québec Longitudinal Study of Child Development who consistently used AST from kindergarten to Grade 2 had significantly lower BMI indices in Grades 1 and 2 than passive travelers, despite a lack of difference in kindergarten.[5] Similarly, Bere and colleagues[6] assessed the impact of cycling to school on the risk of becoming overweight in adolescents from two cohort studies in Norway and the Netherlands. Compared to individuals who did not cycle at baseline and/or follow-up, participants who cycled both at baseline and follow-up had a significantly lower risk (OR=0.44; 95% CI=0.21-0.88), while the odds of becoming overweight was higher among those who stopped cycling at follow-up (OR=3.19; 95% CI=1.41-7.24).

While the above studies provide evidence that AST may contribute to the prevention of weight gain, other recent prospective studies lasting two to six years in length have failed to detect significant differences in anthropometrics between children using active versus passive modes of transport.[7,8,9] Possible explanations for these inconsistent findings include the lack of adjustment for compensatory behaviours and confounding variables, as well as varying definitions of AST.

Individuals may compensate for the additional energy expended through AST over the course of a day by: 1) engaging in less physical activity; 2) engaging in more sedentary behaviour (e.g., waking activities with energy expenditures ≤ 1.5 metabolic equivalents); and/or 3) increasing their energy intake. For instance, a recent review of studies employing doubly-labeled water (a criterion measure of energy expenditure) found that increases in energy expenditure are often offset by compensatory increases in food intake.[10] While the majority of studies that examined differences in physical activity found active travelers to be more active overall than passive travelers, most studies did not account for potential differences in energy intake or sedentary behaviour.[1]

Previous findings of the association between AST and anthropometrics may also be affected by confounding variables. For example, low socioeconomic status has

[i] AST involves using active modes of transport, such as walking and cycling, to travel to and from school.

[ii] A walking school bus is a group of children walking to and from school on a set route under the supervision of at least one adult.[4]

been found to be associated with both increased BMI and AST.[3] AST may also cluster with other energy balance-related behaviours (e.g., consumption of snacks, fruits and vegetables, physical activity, screen time, etc.). Several studies failed to adjust for the effect of these and other important variables, such as age, sex and ethnicity, on the relationship between AST and anthropometrics.[2]

Another important limitation of current AST-related studies is the inconsistency in the classification of individuals as active or passive travelers. For example, in some studies, only participants who used AST at least 50% of the time were classified as "active travelers" while in others, children using AST only once or twice a week have been classified as "active travelers".[1] The latter definition is likely to lead to greater variance in anthropometric indicators among those labeled as active travelers, thereby biasing the results toward the null hypothesis.[1] The use of a continuous measure of AST (i.e., frequency * duration) could address this limitation, while also allowing for the assessment of dose-response relationships.

Given the contradictory nature of the available evidence and the above limitations, the potential role of AST in preventing childhood obesity remains unclear. To increase the quality of evidence, future studies should: 1) measure and account for potential compensatory behaviours and confounding variables; and 2) adopt more consistent definitions of AST, while also considering the use of continuous measures of AST that include both frequency and duration. Studies with longer follow-up periods and stronger study designs (i.e., controlled trials and quasi-experimental studies) are also warranted. However, even in the absence of favourable changes in anthropometrics, AST should be promoted as a way to increase physical activity[1,4] and cardiovascular fitness[2,8] in children and youth.

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Richard Larouche

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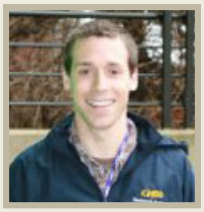

Travis Saunders

Travis Saunders is a Certified Exercise Physiologist and PhD Candidate at the Children's Hospital of Eastern Ontario Research Institute. His PhD focuses on the relationship between sedentary behaviour (e.g. sitting) and chronic disease risk in children and youth.

Main Submission

Fat taste bud receptor CD36 identified in humans: Obesity explanation or excuse?

Sarra Bahna

McMaster University

Obesity is a medical condition in which an individual weighs more than 20% over their ideal weight, as characterized by their body mass index (BMI).[1] There have been a multitude of genetic and environmental factors identified that contribute to the etiology of obesity. However, regardless of the precise mechanism, the results are the same – the caloric intake of affected individuals exceeds their energy expenditure. Over time, their bodies store all unused calories as fat, resulting in a significant increase in overall body fat content. Past studies have shown that many obese people prefer, crave, and actually consume high fat foods more frequently.[2,3,4] So what is it that causes foods with a high fat content to be so attractive?

It has long been determined that the human tongue can distinguish between five distinct tastes, although fat is not one of these. The classical model of fat perception in the mouth was that it relied only on cues from food texture and smell.[5] However, there is an increasing body of evidence that has further revealed the role of the gustatory system in the oral perception of fat,[5,6] whereby the mechanism of taste detection of lipids is triggered by the hydrolysis of triacylglycerols in foods into fatty acids by oral lipases. Animal studies have been used to identify putative fat taste receptors.[7] Of these, the glycoprotein CD36 has been of particular interest owing to its involvement in a number of metabolic pathways with a particular relevance to obesity and obesity-associated complications.[5,6,7,8] For instance, CD36 is known to initiate inflammation in response to excess fat supplies, which subsequently promotes new cascades of metabolic pathologies.[6] Moreover, scientists have discovered that CD36-deficient rodents not only have decreased preference for fatty foods, but also suffer complications in digestion caused by an inhibition of the pancreatic secretions normally triggered by the exposure of their tongues to fat.[6] Importantly, CD36 expression has recently been confirmed on human taste bud cells,[8] and the relevance of the discoveries made in animal models has been further augmented by the realization that many CD36 variants found in rodents are shared by humans.[6]

A research team led by Dr. Nada A. Abumrad from the Washington University School of Medicine in St. Louis has confirmed that individuals with a particular CD36 allele are far more sensitive to the presence of fat in foods than others.[6] Such variation in the CD36 gene between individuals is a potential cause for the disparity in fat preference within a population. Adding insult to injury, Dr. Abumrad further proposed that CD36 levels in humans can be altered by the foods we eat and the amount of fat we consume. As people ingest more fat, they become less sensitive to it, thereby requiring a greater intake to achieve the same level of satisfaction.[6] Taken together, it is evident that the expression of CD36 alleles combined with a lower fat sensitivity can form a solid basis for the development of obesity. Indeed, it is estimated that as much as 20% of the world population expresses the CD36 gene variant associated with lower levels of CD36, and thus has a lower sensitivity to the taste of fat.[9] The question therefore arises – are the rising obesity trends simply a matter of us experiencing a greater predisposition towards the enjoyment of fatty foods than our previous generation?

Genetic screening for potential disease markers such as CD36 is an ever-growing field of research. Participants of such screening processes tend to stress the emotional and social consequences of potential positive test results, rather than the actual physical outcomes. However, the emphasis of the public on nonclinical burdens of a particular trait is potentially more dangerous than possession of the trait itself.[10] While it is true that carrying an 'obesity gene' will lead to greater susceptibility to developing the disease, does what we know about our genes supersede what we can do? The view that the problem 'lies in my genes and is therefore not remediable by my lifestyle changes' further

jeopardizes our health,[10] and is completely erroneous. There is always something we can do.

The pharmaceutical industry is beginning to realize the potential of gustatory perception in the treatment of obesity. Drugs such as orlistat are currently being administered to inhibit the oral lipases that initiate the pathway of fat taste receptor activation.[6] Nonetheless, simply taking anti-obesity pills while not making diet and exercise changes will not solve the problem. We should not use discoveries such as the fat taste bud receptor as an excuse to continue being unhealthy. Lifestyle changes, though difficult, are the only way in which we can combat the immutable force our genes play on our metabolism.

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Sarra Bahna

I am currently pursuing a MSc degree in Neuroscience at McMaster University. My main research interests focus on the mechanisms underlying upregulation of melatonin receptors by valproic acid.

Main Submission

Gamifying health: Using video games for obesity and diabetes interventions

Westerly Luth

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Video games are a common recreational activity for Canadians of all ages: 59% of Canadians play computer or video games[1] and the average Canadian gamer is 33 years old.[1] Rather than being considered an antagonist in the fight against obesity and diabetes, video games can be used to support healthy behaviour such as improving nutrition and encouraging exercise; two of the most important modifiable risk factors for some forms of diabetes and obesity.[2] Video games designed for health education have increased player knowledge, changed health attitudes, and changed health behaviours.[3] For example, children with Type 1 diabetes who played the interactive diabetes educational game *Packy & Marlon*® had higher diabetes-related self-efficacy, self-care behaviours and fewer unscheduled urgent doctor visits.[4] Active games (such as Wii™ Sports, and Just Dance™) have demonstrated positive effects on gamer health: players experience increased metabolic activity compared to sedentary game play.[5] Although exciting, we have yet to demonstrate that educational and active video games can compete with conventional games for player's attention outside experimental conditions.

Video games have been used for educational interventions, but another aspect to obesity and diabetes interventions is motivating people to begin and continue healthy behaviours. Gamification is the application of the motivational elements that make video games "fun" to non-video game applications,[6] like obesity and diabetes interventions. Some of the gaming elements that can be used are: the competitive and supportive social experience within and around the game,[7] the challenge presented[7] and the fulfilment of fantasy.[7] Another element is clearly defined feedback rewards that signal, perhaps more obviously and tangibly than other aspects of a gamer's life, that the player's achievements are acknowledged and worthwhile.[7] Not all of these elements are used in every gamification strategy and other video games elements are used as well. Gamification interventions could be implemented on common mobile devices such as cell phones and smart phones. Gamification principles have been applied to consumer reward programs and on social media sites to encourage users to engage with their services. But what would gamified obesity and diabetes interventions look like?

The Humana American Horsepower Challenge used some of these elements in their intervention in secondary schools to increase walking among students. Children at participating schools walked more, but commitment to the program declined after a few months. Pedometers automatically uploaded step counts to a website.[8] Students unlocked ribbons and customizations by walking more[8] (feedback). On the website, schools' avatars raced against each other[9] (challenge). Critical errors, however, limited the intervention's success. The "game" did not allow students to interact with each other[9] (social interaction). The students' goal (to collectively walk more than other schools thereby winning a grant for their school) was predefined and the students did not feel invested in winning[8] (challenge). Furthermore, slow school computers and pedometer malfunctions contributed to declines in students' engagement.[8] Despite the shortcomings of the Horsepower challenge, more interventions like it are needed to determine how to successfully gamify health interventions.

Another intervention for Type 1 diabetes is Bayer's Didget®. This system integrates accurate self-monitoring of blood glucose with the handheld Nintendo DS® console.[9] Didget® users have access to an online community (social interaction). Players who perform blood glucose tests throughout the day gain access to new levels and receive bonuses for consistent testing habits (feedback).[9] Didget® users can set personalized target range goals[9] (challenge). Users thought Didget® was useful for the management of

their diabetes, but studies need to be done comparing the effectiveness of the Didget® system to other monitoring systems.[9] Using various video game elements, the Didget® system gamifies blood glucose self-monitoring, which may not be intrinsically motivating for many people with diabetes.

Despite these applications, gamification is not foolproof or easy. Research into quantifiable long-term outcomes of gamification interventions is needed to determine if gamification is feasible and cost-effective. Technical malfunctions, long-term maintenance and upgrade commitments are serious challenges to gamified interventions. A related concern that must be addressed is if the use of external gamification motivators will inhibit internal motivation to engage in healthy behaviour when the gamified intervention is discontinued.[10] Further research into video game elements and the particular strengths and pitfalls of specific elements in health intervention strategies must be done. Despite these challenges, gamification is worth exploring for new ways to engage with children and adults to encourage healthy behaviours.

Health researchers can learn about motivating people from video game developers. Challenge, fantasy, curiosity, competitive and supportive social networks, and feedback rewards are only some of the elements of video games that could be used to invigorate health interventions. Bold, creative collaboration between researchers, health care providers, video game developers and companies like Bayer to gamify health behaviours should be encouraged to find the limits of the application to gamification of health interventions for all ages.

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Westerly Luth

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Main Submission

Gut bugs, energy balance, and obesity

Marc R. Bomhof

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Obesity and associated chronic disease has seen a dramatic rise in the past 30 years.[1] Although the etiology of obesity is multifaceted and extremely complex, obesity can be distilled down to positive energy balance. When energy absorbed by the body exceeds energy expended, weight gain is achieved. As the global trend in obesity persists, it is clear that restoring the energy homeostasis equation back to equilibrium remains somewhat of an elusive task. Recently, gut bacteria, or gut microbiota, and the associated short chain fatty acids (SCFA) that they produce have emerged as new players in energy balance and may yield the ability to restore equilibrium. The precise role these bacteria are playing, however, remains somewhat of a mystery.

There are approximately ten times more bacteria cells in the colon than cells in the human body. Comprised of nearly 2000 species and containing around 100 trillion cells, the gut microbiota weighs approximately 1kg and yields a genome size 100 times greater than the human genome.[2] Given the vast 'microbiome' lying in close proximity to the lining of the intestines, microbiota are thought to function as a 'metabolic organ' within the host, providing metabolic and endocrine function, immune system development, and protection against pathogens. Through the process of fermentation, bacteria are able to harness energy from the otherwise indigestible foods entering the colon, producing a range of metabolic by-products such as vitamins, SCFAs (butyrate, propionate, acetate), amino acids, and other odoriferous volatile organic compounds. From a metabolic health and energy balance perspective, these metabolites (in particular SCFA) seem to have a lot of influence.

Research over the past several years has demonstrated the ability of gut microbiota to promote positive energy balance. In studies conducted by Gordon and colleagues, germ free (bacteria free) mice were found to have 40% less total body fat than mice with a 'normal' gut microbiota. When the germ free mice were re-inoculated with gut bacteria, total body fat increased by 60%.[3] Additional studies have found that germ free mice resist weight gain associated with a western diet.[4] According to the authors, these findings can be attributed to a reduction in SCFA production in the gut and beneficial changes in host gene-expression that limit deposition of fat in adipocytes. Noting that the gut microbiota of lean versus obese individuals are dominated by different bacterial phyla groups, research by Turnbaugh and colleagues established that an obesity-associated gut microbiota was more efficient at extracting energy (SCFA) from feces.[5] Confirming these findings, a recent human study found that bacterial groups commonly found in obesity are associated with increased energy extraction from stool.[6]

Despite gut microbiota and SCFA being charged with promoting positive energy balance, there is a wealth of evidence that highlights the ability of SCFA-producing bacteria to improve metabolism in favour of a lean phenotype. Supplementation with prebiotic fiber, a non-digestible food ingredient that is highly fermented in the cecael-colon by *Bifidobacterium* spp., consistently reduces body weight, adipose tissue mass, and consumption of calories. SCFAs, produced from the fermentation of prebiotic fiber, are believed to mediate these effects. Peptide YY, an anorectic hormone that is increased with prebiotic fiber, is reputed to be released from intestinal L-cells after activation of a G protein-coupled receptor by SCFA.[7,8] Interestingly, the same G protein-coupled receptors that are found on intestinal L-cells are also found in adipose tissue. SCFA binding to these receptors has been shown to suppress the release of free fatty acids into the blood stream, which can limit the uptake of fat and development of insulin resistance in non-adipose tissues.[8] Additionally, research by Cani and colleagues has established that bifidogenic prebiotics increase the production of glucagon-

like peptide-1, a satiety hormone, and glucagon-like peptide 2, a gut trophic hormone that is purported to improve intestinal permeability and reduce systemic inflammation.[9,10]

It is clear that gut microbiota and associated metabolites affect energy balance. The evidence to date has identified that microbiota simultaneously have the ability to influence both sides of the energy balance equation, by increasing energy extraction from food as well as improving the ability to metabolize absorbed energy. What is not clear is the extent and direction to which the collective microbiota, as well as individual bacterial species, are influencing energy balance. Further study is required to determine the 'optimal' energy-balance microbiota. Certainly, with such a vast collection of microbes in the gut, there is a world of metabolic potential to be explored and harnessed. With a growing need for obesity prevention and treatment, gut bacteria research may one day yield novel, minimally-invasive strategies, utilizing dietary agents such as prebiotics and probiotics, to manage obesity.

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Main Submission

A 'sweet' take on obesity

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Of the myriad paths, upon which we have set out in pursuit of discovering the cause and ultimately, the treatment of obesity, how is it we continually seem to miss the mark? We are always concerned with low fat, non-fat, half fat, less fat etc... and have been concerned with this for decades. However as Melanson et al.[1] noted, the current literature supports only a weak association, let alone a causal relationship, between total dietary fat and saturated fat intake on weight gain. If not fat intake, then total calories consumed and levels of physical inactivity have been of primary focus for managing the current obesity trends. However a recent report in the Journal of the American Medical Association[2] explained the current national efforts at promoting healthful eating, which have historically focused on low fat diets, low total calorie intake and increased daily physical activity, are having little effect on overweight and obesity rates. Conversely, it is likely that the high intakes of sugar and refined carbohydrates (S&RC) may in fact be causing the most havoc with our body particularly when it comes to weight gain.[3] The average daily intake of sugar in North America in 2009 was 162g/day which is an increase of approximately 20% since 1990.[4] Similarly, in the last 40 years, the average daily intake of fructose, which along with glucose from table sugar, has increased by more than 40%[3] while the intake of refined carbohydrate has risen quite dramatically as well.[5] Interestingly, this trend in S&RC consumption mirrors the rise in obesity[5] while during the same period, physical activity levels have increased,[6] dietary saturated fat consumption has not changed and total calorie consumption among both men and women has decreased.[7] All this suggests that there is a poor association between fat consumption, total calorie intake and physical activity with obesity while a stronger association exists for S&RC.

The effects of S&RC, as described by Kahn & Flier,[8] are chronically high insulin levels which in turn promote adipocyte triglyceride stores (fat tissue) by stimulating lipogenesis (formation of fat), inhibiting lipolysis (breakdown of fat) and increasing the uptake of fatty acids into visceral and subcutaneous fat cells. The chronic consumption of the sugar fructose, that occurs mainly through the increased intakes of high fructose corn syrups, can also promote lipogenesis and insulin resistance; which in turn further increases fat synthesis in adipose tissue.[9] The exact mechanisms of fructose induce lipidimia and insulin resistance remain controversial; however, it is generally understood that the chronic consumption of high amounts of fructose overwhelms the liver, the organ capable of metabolizing fructose, which then disrupts glucose metabolism and glucose uptake pathways ultimately leading to insulin resistance.[10] Additionally, fructose reduces the response of adiponectin, a hormone which, when in adequate amounts, increases insulin sensitivity.[11] Although the effects of S&RC are profound, not all people will respond in a similar way; that is, consuming large amounts of these nutrients will not cause all people to become obese. These observations suggest a strong genetic contribution as one's genetic make-up will influence how a body responds to high S&RC intake. It has been suggested, that the likelihood to respond unfavourably to S&RC (i.e., gain fat more quickly) is determined by one's ancestors. Studies by Pettitt et al.[12], Vickers et al.[13] and Samuelsson et al[14] have all shown that excessive consumption of S&RC by human and animal mothers who are obese and insulin resistant as a result of high carbohydrate diet during pregnancy and lactation, resulted in an increased propensity for offspring to fatten more quickly. Additionally, Bayol et al.[15] found that the offspring of mother rats fed a high sugar diet were more likely during the early part of life to indulge in sugary foods. Thus if gestational intake of S&RC increases the susceptibility of offspring to fatten more easily, then we, a population who has steadily increased the consumption of S&RC over the last 50 years,[5] could be

setting our children up for weight problems not just during childhood (childhood obesity), but their entire life.

It is therefore plausible that the ever increasing trend in obesity is an additive effect of the previous generation overindulging in S&RC producing subsequent generations with increased susceptibility who themselves, engage in a high intake S&RC. Given the current trends presented by Flegal et al.,[2] children will likely be entering adulthood heavier than they ever had before. Conventional wisdom would suggest that higher levels of physical activity and a lower intake of 'bad fats' and total calories is the cure for obesity. However given the information presented, perhaps it is time that we, the research community, acknowledge the powerful effects of sugars and refined carbohydrates on weight gain and obesity and re-focus anew.

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How sugars are sabotaging our health

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In Canada, obesity has nearly doubled from 1978 to 2008. In 2008, based on Body Mass Index, the proportion of obese and overweight individuals over the age of 18 was 25.3% and 36.8%, respectively (Table1).[1] Thus, an alarming 62.1% of the adult population was at an unhealthy weight. The increased availability of processed foods and beverages shows a close temporal relationship with the epidemics of obesity and type 2 diabetes.

Obesity is significantly associated with higher risk for several medical conditions: type 2 diabetes, cancer, hypertension, heart failure and stroke (Table 1).[1] The estimated annual Canadian healthcare costs associated with obesity vary between $4.6 and $7.1 billion.[1] Given the escalating morbidity, mortality and health expenditures of obesity linked diseases, preventative measures have never been more vital. A survey of dietary trends and how carbohydrates, and specifically sugars are metabolized, should focus a response to this serious epidemic.

Dietary Trends

The consumption of processed foods and beverages has climbed steadily over decades. Mozaffarian (2011) made note of US dietary trends between 1965 and 2002, positively associating the consumption of refined sugars and starches and sugar-sweetened beverages with weight gain.[2] During this period the proportion of calories from beverages increased from 11.8% to 21.0% of total calories.[2] Conversely, the consumption of dairy products and unprocessed foods such as nuts, whole grains and vegetables were negatively associated with weight gain.[2] Given the rise in refined sugar and processed food intake, an examination of metabolism could guide necessary action.

Carbohydrate Metabolism

Most carbohydrates, with the exception of fiber, are metabolized as fructose and/or glucose, the main sugar building blocks. When physiological doses of carbohydrates are consumed, homeostasis is maintained with resulting normal blood sugars, blood pressure and lipid profiles. However, with the advent of processed foods high in starch and beverages high in sugar the consumption of carbohydrates has reached pharmacological doses. It is difficult to quantify physiologic and pharmacologic doses given individual variability in insulin resistance and carbohydrate metabolism. However, the Institute of Medicine noted the range of median carbohydrate intakes of 220-330 g/day dramatically exceed minimum recommendations of 130 g/day.[3] Increasing evidence shows carbohydrate metabolism is altered in obesity leading to a cascade of maladaptive lipid metabolism.

Table 1: Canadian population divided according to Body Mass Index

Classification	BMI (kg/m^2)	Risk of Other Conditions
Underweight	< 18.5	Mildly increased
Normal	18.5-24.9	Average
Overweight	25.0-29.9	Mildly increased
Obese Class 1	30-34.9	Moderate
Class 2	35-39.9	Severe
Class 3	≥ 40.0	Very severe

With the over-consumption of refined sugars, starches, and refined grains the body diverts excess calories towards triglyceride production via liver lipogenesis. Fructose, under physiologic conditions, is metabolized into glycogen and some is broken down for energy. Any remaining fructose has been shown to increase production of proatherogenic lipoproteins – a result of excess triglyceride production.[4] Glucose is utilized at approximately 50 calories per hour at rest; glucose not utilized must be stored as glycogen or converted into triglycerides. The consumption of a low-fat calorie balanced diet with a high glucose and/or starch content such as potatoes or pasta stimulates liver lipogenesis, increasing serum triglycerides even in normal weight individuals.[5] Additional evidence supports

the association of high fructose consumption with hypertension, dyslipidemia, visceral adiposity, increased insulin resistance, and increased inflammation.[4] Thus, excess fructose and glucose have similar health impacts – dyslipidemia and obesity.

The connection between dyslipidemia and obesity is insulin resistance and ensuing hyperinsulinemia. Adipose tissue in obesity contain high amounts of inflammatory cells and releases elevated amounts of inflammatory mediators precipitating insulin resistance.[6] With insulin resistance being proportional to the amount of central adipose tissue, the body compensates with relative elevations in insulin.[6] Both promote liver lipogenesis, by diverting consumed sugars into triglyceride production and elevating apolipoproteins, transport proteins essential for triglyceride transport within the blood. With a high carbohydrate diet there is predominance for proatherogenic lipoproteins.[7] The resulting dyslipidemia with inflammation is one manifestation of a pharmacological dose.

Intervention

Fortunately, the abnormalities associated with obesity and excess sugar consumption can be controlled and reversed. Although voluntary calorie restricted diets can be effective, they first require some degree of weight loss to reduce insulin resistance and improve lipid profiles.[8] Moreover, they are difficult to maintain, with rebound being common. However, a low carbohydrate diet is not calorie restricted, does not require weight loss to show near immediate reductions in liver lipogenesis followed by improved lipid profiles, and re-establishes normal carbohydrate homeostasis.[8] Research has shown that significant satiety and weight loss are associated with the consumption of dairy, nuts, protein and foods high in fiber, and that weight gain results from the consumption of refined sugars and starches and sugar-sweetened beverages.[2,4,9] Lowering the intake of simple sugars and carbohydrates broken down into simple sugars — pasta, bread, potatoes and white rice — increasing dairy, nuts, protein and fiber rich carbohydrates and allowing for moderate increases in fat would reduce liver lipogenesis and re-establish normal homeostasis including control of caloric intake. Although this necessitates exchanging some carbohydrates for fats, their addition has been shown not to adversely affect lipid profiles or increase risks for chronic disease.[10]

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Main Submission

Using new technologies to improve individualized self-management of diabetes

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Obesity, a major public health concern worldwide, has reached epidemic proportions in North America. This has resulted in exorbitant healthcare costs, accounting for 2-7% of total healthcare costs.[1] A number of health complications have been linked to obesity, including: psychosocial difficulties, cancers, cardiovascular problems, and type 2 diabetes.[2] In diabetic patients, closely observing blood glucose (BG) response to food consumption and physical activity over time has been shown to be an effective way of exploring BG change. For instance, examining BG response using blood-testing strips has shown that BG increased rapidly after meals and was positively correlated with fat mass percentage.[3] Furthermore, collecting dietary, physical activity and BG data in real-time has demonstrated an opportunity to allow for *individualized* feedback that could be used by a diabetic patient to enhance their self-management of diabetes.[4] This commentary explores advancing research and new technologies for improved diabetic patient self-management.

Real-time self-monitoring of blood glucose (SMBG) affords an opportunity to identify the patterns of daily insulin secretion via complex datasets comprised of activity, physiological and nutritional data. SMBG serves as an important adjunct to hemoglobin A1c (HbA1c) testing and can differentiate between fasting and hyperglycemia; detect glycemic episodes; recognize and monitor resolution of hypoglycemia; in addition to providing instantaneous feedback to patients about their food choices, physical activity, and medications. Pattern analysis is an organized approach to recognize glycemic patterns within SMBG data, allowing for the appropriate action to be taken based upon those results. Pattern analysis involves: [1] glucose targets [2] obtaining data regarding BG levels, carbohydrate intake, medication, activity levels and emotional/physical stress [3] analyzing data to recognize patterns of adverse glycemic episodes, assess any influencing factors, and apply appropriate action(s) and [4] performing ongoing SMBG to measure the impact of any treatment changes made.

Employing a novel data collection methodology, Doherty[4] designed a pilot study that consisted of a set of wearable sensors connected to a BlackBerry Smartphone with a continuously running software program. The Smartphone and sensors in this study included: a GPS receiver; 3-axis accelerometer and ECG and heart rate monitor; and a continuous BG monitor. Data was compressed, encrypted to ensure patient privacy, and transmitted to a central server for storage, processing, display, and further interaction with patients. An electronic food diary was recorded and made available the amount of sugar, carbohydrates, calories and medication consumed, while automated activity diary software was able to calculate how long patients were engaged in specific activities.

Findings from the Doherty pilot study demonstrate the potential for accurately predicting patient-specific BG levels. Not surprisingly, findings from this pilot study suggest that diet and physical activity are closely related to BG fluctuation. However, and more importantly, the study demonstrates the ability to predict *when* a change in BG is likely to occur. This information is of clinical importance in efforts to prevent hypoglycemic episodes and avoid unnecessary trips to traditional healthcare facilities. The pattern analysis techniques employed by Doherty provides an opportunity for clinicians and patients to learn what would trigger adverse fluctuations in a patient's BG. Additionally, this approach to understanding SMBG data facilitates appropriate therapeutic modification, leading some researchers to suggest that pattern analysis of SMBG can be of equal or greater value than traditional measurements of HbA1c levels.[5] This notion is complimented with further evidence indicating SMBG-based structured pharmacological and educational programs are able to empower patients to achieve physical activity and

nutritional goals, and encourage patients and physicians to utilize SMBG to optimize therapy.[6] Nevertheless, a challenge remains that involves the knowledge translation and exchange components of new data collection techniques afforded with SMBG. For instance, the manner in which data from the Doherty pilot study is presented to patient and care provider needs further refinement. Despite the controversy of the perhaps premature criticisms regarding the cost-effectiveness and clinical benefits of SMBG, it is suggested that further research is necessary to identify subgroups for whom SMBG might be useful.

While findings from Doherty[7] provide promise, a challenge remains in updating policy, mainstream healthcare strategies, and patient education to enhance and empower diabetic patients. New technologies provide an opportunity for diabetic patients to better understand the idiosyncratic nature of their health complications and how to better self-manage their disease.

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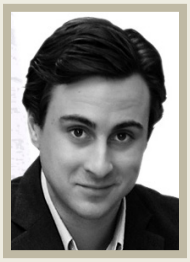

Eric Sadowski

Eric is a PhD candidate, in the Health and Rehabilitation Sciences Graduate Program at the University of Western Ontario. Eric's research focuses on new rehabilitation monitoring and measurement methods.

Main Submission

Obesity and diabetes among children: Nutrition-related educational and practical barriers and future opportunities

Gillian Mandich and Leigh Vanderloo

University of Western Ontario

For the first time in history, parents are expected to outlive their children.[1] This statement reflects Canada's current obesity epidemic, during which obesity rates have tripled over the past thirty years.[2] The rates of type 2 diabetes have also significantly increased within the Canadian population (from 4.2% in 2000 to 7.3% in 2010).[3] Consequently, there is a clear need to address both obesity and diabetes, particularly given their strong correlation.[3] Physical activity and dietary intake represent two modifiable behaviours associated with obesity and diabetes; this paper will address dietary intake by examining two nutrition-related barriers that inhibit children's health and will suggest potential solutions.

Parents/Guardians: Problems and Potential

Ideally, parents/guardians (hereafter used interchangeably) would model healthy food choices and create supportive home environments that normalize healthy eating. However, a barrier facing children in achieving a well-balanced diet is the absence of strong parental role models.[4] Children tend to mimic their guardians' nutritional choices, good or bad,[5] and adults should be mindful of the impact their nutrition-related actions have on their children's food choices and perceptions of 'normal' eating.

Given the strong influence parents have over their children's lifestyle choices, coupled with their control of foods entering the home, a family approach to addressing home-based dietary choices seems important. One solution is to schedule regular family mealtimes.[5] Given that food preferences and eating habits are formed at a young age,[6] consuming meals as a family can provide opportunities for parental modeling and can promote healthy choices. Further, including children in daily meal preparation early on, and at a level suitable for their age – from the job of choosing one of dinner's vegetable options, helping to garnish the meal to look attractive, or peeling/washing fruits for dessert – is also a creative and important approach to generating interest and normalizing involvement in healthy food preparation.[6,7] Without opportunities to contribute to dietary choices and practice food skills at an early age, children's confidence in making healthy food choices can be hampered long-term. Additionally, insufficient nutritional education among parents may lead to the exchange of inaccurate information with their children. Guardians need to be armed with appropriate knowledge and be supported in their efforts of raising healthy children. Opportunities for nutrition-based learning need to be provided to parents in a variety of formats, such as workshops, television segments, seminars, or practical written tips sent home from schools.

Nutrition-Related Knowledge: Inadequacies and Instructional Opportunities

Lack of nutrition knowledge is a second barrier preventing children from making healthy dietary choices.[4] In fact, researchers have promoted nutrition education as the first line of defence for children with type 2 diabetes.[7] Within a context of challenging physical and social environmental influences, such as the overabundance of unhealthy food options and junk-food marketing targeted at youth,[8] children often lack knowledge to make healthy choices. For example, a recent study found that many children aged 8-18 years (54-72%) were unaware that trans-fatty acids were in processed foods, including French fries.[9] Fortunately, suitable nutrition education can translate into positive lifestyle changes, given the demonstrated correlation between comprehensive nutrition education interventions and healthy food preparation practices.[9] Consequently, in addition to ensuring parents are on board, it is equally crucial that nutrition education be delivered *directly* to children. Recently, investigators summarized the importance of integrating 'fun' to help instil long-lasting interest in food-related knowledge and skill development.[11] Engaging children in hands-on learning, such as food preparation skills, eyes-closed 'taste tests', and myth-

busting educational activities (e.g. how much sugar in a can of pop) can be fun, entertaining ways to fully engage and motivate children to learn.

Schools present an ideal setting to teach children about nutrition. A recent meta-analysis found beneficial effects on Body Mass Index for children (6 to 12 years) when school curriculum included healthy eating.[10] Researchers suggest children be taught specific nutritional information regarding portion size, healthy balanced meals, and low fat choices.[4] Nutrition education is a fundamental component in the quest to help reduce childhood obesity and type 2 diabetes. Drastic measures are required, including lobbying officials for the re-introduction of cooking skills within schools and/or accessible extra-curricular food skills programs tailored to children and families. The "Cook-it-Up!" program, a hands-on community-based program for youth that included guest chefs, field trips, and a combination of education and practical skill development, represents one such novel program that, given its evaluative findings in terms of cooking skills, self-esteem, and food choice improvements, may be considered as a model from which to build.[11]

What's next?

Obesity and diabetes currently affect the lives and positive experiences of too many Canadian children. The physical and social environments discourage children from making healthy dietary choices. That being said, parents and schools represent two important sources to help combat these issues. The evidence is clear that family support,[5] combined with engaging and hands-on food-related programming for children, can help increase food knowledge and healthy choices while enhancing children's self-confidence and self-efficacy.[12,13] This call to action highlights the urgent need to examine novel ways of combating these public health concerns so that children may reclaim their longevity and enjoy healthier lives.

Acknowledgments

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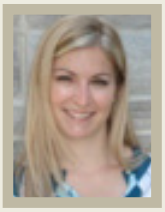

Gillian Mandich

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Main Submission

Misguidance in diabetes nutrition: Food labeling and agency recommendations

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University of Western Ontario

Walking through the grocery store, perhaps hungry after a workout or a busy day, Canadians are bombarded by snazzy food marketing. "*Low-Fat*", "*High in Fibre*", "*Zero Trans Fat*", "*Ancient Grains!*", the bright words jump out as we navigate the store trying to make choices that are both good for our bodies and enticing for our appetites. Food labels throughout grocery stores broadcast conflicting and one-sided messages about the health appeal of their respective products: advertising often boldly proclaims the "healthy" aspects of products, while marginalizing those aspects that are less healthy. Packaging for whole-wheat crackers, for example, might boast "high in fibre", while the equally important health-related reality of the crackers' high sodium content is only subtly revealed in the requisite Nutritional Information fine print. For consumers, choosing foods that will fuel us appropriately and keep us healthy is not a new problem, but the variety of food products becoming available to us, and their prolific marketing is an overwhelming factor in the diabetes epidemic in Canada.[1]

Research has indicated that it is easy to be swayed by the claims made on food packages.[2] The tendency of food advertising to overemphasize the nutritional quality and health benefits of certain products tends to misinform consumers, which can create barriers to making healthy food choices. For instance, overemphasizing and over advertising positive health-related qualities of foods purposefully omits less positive realities. One example of this selective advertising can be found among certain yoghurt products, which often boast their excellent calcium content and avoid revealing their particularly high sugar content.

Eating well in spite of selective food advertising becomes even more complicated for individuals living with diabetes. In order to manage their health, people living with diabetes are often implored to use complicated paradigms that include attuning to glycemic loading, tracking fasting blood glucose levels, and striving to reach glycated hemoglobin targets.[3] These strategies are typically an adjunct to the already challenging practice of calorie counting. Navigating these complicated management paradigms is exacerbated by targeted advertising on food packages.

Nutrition management of diabetes is further being derailed with ambiguous and often incongruent messages about healthy eating from public health entities. For example, although the Canadian Diabetes Association (CDA) does its best to simplify healthy eating in its "Just the Basics" publication, which is part of the clinical practice guidelines for healthcare professionals,[4] their information can be abstruse. A sample meal plan describes two options, one for small appetites (approximately 1800 calories) and another for large appetites (approximately 3200 calories), with a startling caloric difference between the two menus. A subjective description of "small" and "large" appetites, without further explanation or even a calorie count to accompany the meal plan creates ambiguity and confusion.

Another discrepancy in the CDA's "Just the Basics" publication lies in its breakfast suggestions, which include cold cereal as a healthy option, despite the presence of large amounts of sugar in many cereal products.[5] The CDA best practice guidelines emphasize the importance of paying attention to the glycemic index of foods for optimal diabetes nutrition, but then their choice to list cereal as a 'healthy' breakfast option ignores the probability of glycemic spiking that comes along with the high sugar content in many commercially available cereals. In this sense, the CDA's guidelines for diabetes management are not in synch with the CDA's own food intake recommendations.

In an effort to make food choices easier, the Heart and Stroke Foundation created "Health Check", a labelling system designed to help Canadians eat well.[6] This is a great idea in theory, but it is facing increasing criticism for giving

healthy ratings to products high in sodium and therefore not conducive to healthy eating.[7] One of the challenges with the "Health Check" approach is that nutrition experts are not unified in their opinions about what constitutes healthy eating. A variety of recommendations such as the DASH (Dietary Approaches to Stop Hypertension) diet, the Glycemic Load eating strategy, the Mediterranean diet, and low-carbohydrate diets have all been touted at different points as the "best diet" for people living with diabetes. Interestingly, a recent randomized controlled trial found that people eating different macronutrient ratios experienced similar weight loss,[8] a common goal for people managing Type II diabetes. These weight-loss results are consistent with reviews of various diets for people living with diabetes.[9] Many of these "best diets" have underlying common traits, such as eating a wide variety of fruits and vegetables, eating foods that are good sources of fibre, and reducing intake of trans and saturated fats. Taken together, it appears the underlying answer to healthy eating for prevention and management of diabetes may ultimately be simplified through quality food choices and portion control.[9]

We suggest that a public health approach to reducing the current diabetes epidemic should involve improving the eating patterns of all Canadians by empowering consumers to make good choices. We believe that Canadians want to eat a healthy diet, but efforts to do so have been hampered by the bombardment of health-claims in food marketing and by the dissemination of confusing messages about healthy eating, including, some from well-intentioned public health agencies. We encourage Canadian regulators to consider the broad effects of marketing pre-packaged food as 'healthy' and we hope that agencies such as the CDA and the Heart and Stroke Foundation will streamline messages and recommendations for healthy eating.

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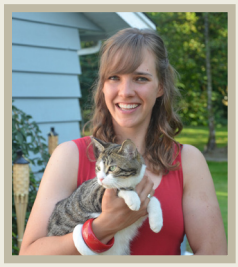

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Main Submission

Carbohydrate conundrum: Why Canadians cannot fit into their skinny genes

T. Dylan Olver and Graeme W.R. Thomas

University of Western Ontario

The Numbers

Between 1979 and 2004, adult Canadian obesity rates increased ~67%.[1] Accordingly, from 1999-2009 age-standardized prevalence of type II diabetes rose ~70%.[2] In light of these dramatic increases, the validity of current diet recommendations warrants questioning.

The Acceptable Macronutrient Distribution Range (AMDR) recommendations contained within the North American Dietary Reference Intake (DRI) report are thought to represent the nutrient intake required to reduce the incidence of chronic disease.[3] Established at 45-65% of total daily energy intake, the AMDR for carbohydrate amounts to 255-365 g/day on a typical 2250 kcal diet. Considering the human body can produce sufficient carbohydrates to meet health requirements via hepatic gluconeogenesis[3,4] and carbohydrate overconsumption has been linked to hyperglycemia and hyperinsulinemia[3] one must question the claim that the AMDR reduces risk for chronic disease. If the AMDR for carbohydrate does not reflect physiological need, it is plausible that excess carbohydrate intake promoted by the AMDR is a contributing factor to the ongoing obesity and type II diabetes epidemics.

Cause for Questionning

Support for this hypothesis is advanced in part through a second nutrient recommendation contained within the DRI report: the Recommended Dietary Allowance (RDA). The RDA for carbohydrate is established at 130 g/day and corresponds to the dietary intake level considered adequate to meet the requirements of ~98% of the healthy population.[3]

Adult Canadian carbohydrate consumption is currently estimated at ~300 g/day;[5] an amount consistent with the AMDR recommendation. However, as obesity rates continue to increase, the question must be asked: Are the additional > 150 g of ingested carbohydrate (estimated intake – RDA) protecting Canadians from chronic disease as the AMDR suggests? The DRI report is unable to form clinically relevant conclusions on the matter and cites evidence from traditional populations and experimental studies that demonstrate humans can thrive on low-carbohydrate diets with no adverse effects on health or longevity.[3] Further, carbohydrate consumption is theoretically non-essential as the liver can synthesize sufficient glucose to sustain health (~240 g/day), provided the diet consists of adequate amounts of fats and protein.[3,4]

Given the modest amount of carbohydrate necessary to meet health requirements (RDA; 130 g/day), coupled with evidence that this amount can be produced/consumed and sustained practically without harm, is it conceivable that current carbohydrate intake may lead to metabolic complications? The DRI acknowledges such risks by explaining that chronically high-carbohydrate diets may lead to hyperinsulinemia, hyperglycemia and insulin resistance/type II diabetes.[3]

A Refined Society?

In addition to the hyperinsulinemic potential of a high-carbohydrate diet, the progressive milling and refining of grain (i.e., whole grain < cracked grain < coarse flour < fine flour) produces a stepwise increase in insulin secretion.[6] With refined breads, pastas, cereals and sweetened beverages commonplace today,[5] the associated increase in insulin stimulation[3,7] may result in heightened stress on the pancreas and liver.

Particularly troublesome is how quickly acute bouts of hyperinsulinemia can initiate the transition from a normal to insulin-resistant state. After only one-week of carbohydrate (fructose) overfeeding, fasting blood glucose

becomes elevated and symptoms of insulin resistance develop.[7] However, following weight-loss in previously obese participants with type II diabetes, signs of insulin-resistance persist and often weight-loss is not sustained.[8] It is possible this imbalance reflects a genetic-predisposition favouring the development of insulin resistance but not the reverse.

What's Old is New Again

Although the AMDR is thought to protect from disease, it is worthwhile noting that 'diseases of civilization' are typically absent in hunter-gatherer societies. Total carbohydrate content of hunter-gatherer diets[9,10] is significantly lower than both the AMDR and current consumption (22-40% vs. 45-65% of total energy intake respectively). Hunter-gatherer diets are also notably devoid of refined grains and added sugars.[10]

Recently, the health benefits of a hunter-gatherer diet have been realized and used in a clinical setting to improve metabolic status.[10] This should not be considered surprising as the carbohydrate provided by a hunter-gatherer diet closely aligns with the RDA and may be considered sufficient to support optimal health.

Canadian Carbohydrate Considerations

Canadians' carbohydrate consumption is estimated at ~300g/day. Although this intake closely aligns with the DRI-AMDR,[2] it far exceeds what both human physiological requirements and modern day hunter-gatherer diets estimate are sufficient for healthy living.[3,9] Of greatest concern, current carbohydrate intake too frequently consists of added sugars and processed foods, which can elicit hyperglycemic and hyperinsulinemic responses.

If Canada aims to improve health status, updated carbohydrate recommendations are necessary. These authors contend that carbohydrate recommendations more closely aligned with the DRI-RDA (130 g/day; or 20-40% of total calories) are a more appropriate target for optimal health. This level of intake appears to satisfy human biological requirement and is in agreement with our natural, ancestral eating patterns. To minimize unhealthy metabolic stress, nutritional recommendations must emphasize the consumption of unprocessed foods (vegetables, fruits, nuts, seeds, legumes and whole grains) at the expense of refined grains and added sugars.

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T. Dylan Olver

Combining the expertise of the Neurovascular Research and Exercise Biochemistry Labs from University of Western Ontario, Dylan's research investigates the role of acute and chronic alterations in glycemic status (glucose and insulin) on blood flow control.

Graeme Thomas

Working under the supervision of Dr. Peter WR Lemon chair of The Exercise Nutrition Research Lab at University of Western Ontario, Graeme's research focuses on developing health coaching software to compliment an 8-week fat loss program designed to improve body composition in various clinical populations.

Main Submission

The continuing epidemics of diet-related disease: Environmental drivers of the modern diet and why governments must get involved

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University of Toronto

In September 2011, New York hosted the first UN General Assembly High-Level Meeting on the prevention and control of non-communicable diseases. This meeting's timing was by no means premature: worldwide, obesity and overweight already cause more deaths than underweight.[1] Together, obesity and other diet-related diseases, including type 2 diabetes, increasingly pose a major global health burden. Canada is no stranger to this grave public health challenge: rising rates of obesity and diabetes seriously threaten the stability of our public health system.[2,3]

The strikingly rapid rise in rates of obesity and diabetes clearly point to environmental drivers. Considering the environmental causes of these largely preventable diet-related conditions is thus essential for devising effective public health interventions. Below, I explore several drivers of unhealthy diet within the modern food environment and argue for a more prominent role of governments and policy-led interventions.

The "modern" diet (rich in energy-dense, highly processed foods) is commonly recognized to play a key role in the development and management of both obesity and diabetes. There is a growing consensus among experts that recent profound changes in the global food system (which have shaped the modern diet) have been the dominant drivers of soaring rates of obesity and related diseases.[4,5] Indeed, our current dietary patterns come as no surprise considering a food supply replete with cheap, highly palatable, and energy-dense foods, along with improved food distribution systems and aggressive food marketing of the least healthy foods.[4]

While food calories and single nutrients (e.g., fats, carbohydrates) currently dominate the conversation about diet and poor health, this narrow focus may be obscuring a highly related issue far more deserving of attention: the consumption of a diet rich in highly processed foods. One prominent nutritional epidemiologist argues that it is the "ultra-processing" of foods (i.e., transforming raw or minimally processed foods such as milk, oils and sugar into ready-to-eat foods such as cereals and soft drinks, often by adding preservatives and chemical additives) – and much less so the food's nutrient or calorie content – that may be a key factor linking the modern diet with disease.[6] Indeed, what we *don't* eat may be most salient for poor health. Diets rich in wholesome, minimally processed foods are consistently linked with lower rates of weight gain and chronic disease.[7] Yet, ultra-processed foods are widely distributed, heavily marketed and extremely profitable, and are precisely the types of foods that line the shelves of nearly all food (and many non-food) establishments.

Ubiquitous access to unhealthy foods is even more pernicious if we consider the insidious effects of this food landscape on our innate responses to food. A rich evidence base shows that unhealthy food choices and overeating are largely automatic and unconscious responses to a barrage of unappreciated environmental cues.[8] Such cues include large portions sizes, variety of available foods, and food advertising – all of which consistently boost food intake. The ubiquity of – and our high sensitivity to – such food cues in our daily environments place most food-related behaviours well beyond the realm of conscious, rational choice. In other words, the choice of foods and amount consumed are much less a matter of "free will" than is commonly believed.[9]

In view of this "toxic" food environment and our limited capacity to resist its temptations, we can see a clear disconnect between this reality and the prevailing public health messages to individuals about ways to prevent and manage obesity and diabetes (e.g., *simply make healthy food choices*). To date, such context-ignoring educational strategies have been largely ineffective and will continue to fail at the population level. In contrast, the most

sustainable and cost-effective strategies aimed at reversing environmental drivers of diet-related disease will almost always be policy-led and involve various levels and sectors of government.[4,5] Such strategies could include regulating food advertising, mandating healthy food policies within public institutions, and realigning agricultural policies to incorporate health considerations.

Thus, governments, given their core mandate to protect and promote public health, have a leading role to play in stemming the epidemics of obesity and diabetes by crafting policies to address their environmental roots – a view strongly endorsed by the recent UN High-Level Meeting on chronic diseases.[10] To date, however, the Canadian government (and most governments worldwide) have done little to address this serious problem[a] and have largely delegated the responsibly for obesity and related diseases to individuals, the private sector and non-government organizations.[4] Undoubtedly, the degree of political difficulty in implementing policy-led interventions will continue be high: reasons for this certainly include the powerful lobby force of food and related industries against any government regulation of the food market.[7] Yet, the continuing epidemics of obesity and diabetes will not be significantly slowed without political leadership, regulation and investment in research (including evaluation of various policy changes). While obstacles to policy-led actions are considerable, the societal costs of inaction are far more staggering.

[a] Although recent efforts in Canada have been made to ignite a conversation about addressing the social and physical environments that drive preventable chronic diseases (e.g., the 2010 Federal, Provincial and Territorial Framework to curb childhood obesity), very little action has ensued. To this day, Canada still lacks a comprehensive strategy on obesity and related chronic diseases.

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Main Submission

Health at every size in Canada: An emerging paradigm shift?

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Health professionals, mass media, and the diet industry all exhort obese Canadians to lose weight. However, a shift in how Canadians view weight and wellbeing may be subtly emerging. In 2011, the federal government initiated the *Our Health, Our Future: A National Dialogue on Healthy Weights*. This online forum allowed the public to publish ideas and vote on methods to curb childhood obesity. The most popular strategy was to adopt a Health at Every Size Approach (HAES), rather than focusing on weight loss.[1] HAES promotes consuming healthful foods, honouring internal cues of hunger and satiety, and engaging in enjoyable physical activity. HAES is weight neutral; its proponents do not view weight loss as a goal. This support from the Canadian public for an HAES-approach to child health suggests Canadians may be becoming increasingly conscious, and possibly critical, of the messaging surrounding obesity. Similar concerns have arisen among academics and health professionals.

Obesity, Weight loss, and Health

The economic burden of obesity is frequently referred to in health literature. This focus risks characterizing obese individuals themselves as 'burdens' on the healthcare system. Anti-obesity discrimination is increasing in work, school, and social situations.[2] Public health messaging promotes the benefits of weight loss. This messaging often assumes a simplistic "eat less, exercise more" attitude. However, diet-induced weight loss activates somatic and psychological 'homeostatic pressures' to stimulate weight regain. These mechanisms include reduced satiety and energy expenditure and increased hunger.[3] These pressures produce weight regain in over 90% of weight-losers.[4] There are potential negative physical and psychological effects of dieting, such as compromised skeletal integrity, weight cycling, and disordered eating.[5] Additionally, physically active obese individuals may have greater cardiovascular fitness than inactive individuals, regardless of weight status.[6] Overweight status (BMI 25-30 $kg*m^{-2}$) has been associated with decreased or neutral mortality risk in American, Canadian, and international samples.[5,6] Obesity (BMI > 30 $kg*m^{-2}$) has demonstrated a protective or neutral effect among some chronic disease populations.[5,6]

Critics of HAES fear size acceptance may lead to binging and weight gain.[5] However, randomized control trials of HAES interventions found maintenance or improvement in dietary, clinical, psychological, and physiological outcomes. No adverse outcomes, including weight gain, were reported in the six completed studies.[5]

Media, the Diet Industry, and Public Health

The concept of health has also been co-opted as a marketing tool by the diet industry and the appearance-conscious media. This may erode the credibility of public health; health as a resource for improving one's life may become conflated with media-influenced beauty standards. Among individuals who have failed to lose weight or who have suffered negative consequences from weight loss efforts, these traumatic past dieting experiences may generate resentment toward public health officials and medical practitioners. This resentment runs the risk of resulting in further entrenchment; overweight individuals may view themselves in opposition to public health, rather than as working in concert with these agencies to improve health and wellbeing. An exclusive focus on weight loss may lead individuals to choose unhealthy dieting options, develop eating disorders, internalize stigma, and suffer consequent mental health issues.[5,7] Perhaps most damaging, rather than viewing health practitioners or public health officials as potential partners in improving quality of life, obese individuals may shun preventive health care in order to avoid biased healthcare professionals.[7]

Evidence of a Paradigm Shift?

Some health professionals have begun to focus on the demonstrated cardiometabolic benefits of balanced nutrition and physical activity, independent of weight loss.[5] In 2011, the first Critical Dietetics Conference was held in Toronto. Attendees adopted a critical approach to the prevailing public health attitude concerning obesity. The 2011 Annual American Dietetic Association Conference included a debate on the benefits of implementing a HAES approach to public health. Dr. Gail McVey, at the Sick Kids Hospital in Toronto, has produced teacher resources that adopt a HAES approach that encourages healthy behaviours without triggering body image issues or eating disorders.[8] Clearly, while still controversial, these critical perspectives on obesity prevention are gathering momentum.

Canadians appear increasingly invested in a non-weight-centric approach to health. In practice, this would be challenging to implement without a fundamental culture change among health researchers and policy-makers. Researchers no longer necessarily provide supporting evidence that weight loss is inherently healthy and risk-free, which is a necessity for other claims in scientific writing.[9] A British Columbia policy analysis found adopting weight-neutral public health language feasible but not government-funded HAES studies.[10] However, the salience of the obesity issue among the public may produce sufficient political will to begin a paradigm shift in Canada's approach to obesity prevention. If public health is truly inclusive, it cannot alienate citizens who would benefit most from compassionate preventive health and treatment provision. Implementing a HAES position on diet and physical activity may be a more empowering, life-affirming, and efficacious approach to promoting health than a weight-centric model.

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Lazy, stupid, worthless: A critical commentary of weight bias in healthcare

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When you think about 'fat' individuals (adults with a BMI of 25 kg/m^2 or greater) what are some of the words that first come to your mind? Lazy? Stupid? Worthless? While this question may seem harsh and perhaps even uncomfortable to answer, a systematic literature review investigating the occurrence of weight bias and stigma among healthcare professionals revealed that physicians, nurses, dietitians and fitness professionals often attribute negative qualities towards overweight and obese individuals.[1] Common attributions expressed included "non-compliant", "lack of motivation/lazy", and "lack of self-control/self-indulgent".[2] These beliefs support a view that overeating and sedentary behaviour causes individuals to be or become overweight or obese.

Accordingly, the 2006 Canadian Clinical Practice Guidelines on the management and prevention of obesity prescribes a "lifestyle medication program" aimed to promote weight loss, to decrease individuals' body weight by reducing daily energy intake by 500-1000 calories and increasing energy expenditure by engaging in at least 30 minutes of moderate physical activity.[3] While promoting physical activity and healthy eating may not seem like dangerous prescriptions, the clinical focus on weight as an indicator of 'satisfactory progress' has been suggested to underlie the pervasiveness of weight bias within health care.[1] Despite advances in research since its publication, the clinical practice guidelines are the most current set of recommendations geared towards the management and prevention of obesity in Canada.

Weight-based stereotypes within the medical field have been longstanding[5] and recent studies have begun to demonstrate the negative impact of such stereotypes on health outcomes. For instance, weight-based discrimination was shown to be positively associated with depression, body image disturbances, and negatively associated with self-esteem.[1,4,6] Similarly, weight-centered (weight loss) interventions were shown to contribute to body dissatisfactions, disordered eating, weight cycling, and avoidance of health prevention screening and exams due to fear of humiliation, distrust, and unsolicited advice regarding weight loss.[1,4,6]

Some researchers[4,6,7,8] have argued that the war on obesity is actually a war on obese individuals and the relationship between health and weight may not be as significant as we have been led to believe. For instance, a cross-sectional study of over 5000 American adults revealed that 51% of overweight individuals and 31% of obese individuals showed normal cardiometabolic indicators such as elevated blood pressure, triglycerides, cholesterol (HDL), and glucose, as well as insulin resistance and systemic inflammation.[9] Conversely within the same sample, 23.5% of normal weight individuals (defined by a BMI 18.5-24.9kg/m^2) had abnormal cardiometabolic indicators. While similar evaluations are needed in Canada, metabolic fitness among overweight and obese individuals may help to explain why a longitudinal study of Canadian adults showed a lower risk of death among overweight individuals compared to normal weight individuals.[10] While we cannot ignore that many individuals, regardless of their weight continue to demonstrate metabolic abnormalities, research has demonstrated that obese individuals can improve metabolic indicators independent of weight loss.[11]

A recently published review paper evaluated the evidence of a weight-neutral practice called Health at Every Size^{SM} (HAES).[4] The review included six randomized control trials (RCT) comparing a HAES group to a control or diet group. This alternative practice challenges the mentality that weight equates to health and encourages practitioners and patients to shift their focus away from weight.[4] According to the principal tenets of HAES, individuals are instead, encouraged to respect their natural body shape and size while relying on their hunger and satiety rather than

diet, and are guided in active embodiment rather than rigid exercise regimes.[4] Active embodiment encourages individuals to incorporate joyful body movement into their daily routine as a means to experience the physical and psychological benefits independent of weight loss. While there are limited published HAES studies, the current evidence demonstrates a potential mechanism to overcome weight bias within health care whilst improving the health and well-being of individuals with BMI above established "normal" cut offs, independently of weight loss.

All six RCT HAES groups improved not only their metabolic indicators (e.g. blood pressure, blood lipids) but also, their physical activity levels and eating disorder pathology. Most noteworthy, positive changes in mood, self-esteem and body image were observed. Furthermore, compared to the control group (i.e. weight-loss centered approach), the retention rates were substantially higher in the HAES group.[4] In one study, the attrition rate was five times higher (42%) in the diet group versus the HAES (5%) group[4] demonstrating a potential shift in patient-centered care.

Despite years of research demonstrating that weight-centered approaches result in poorer outcomes and negative health consequences,[4] the continued focus on weight within healthcare continues and thereby, raises questions about the providers' primary ethical responsibility: to do no harm. While the prevalence of chronic illnesses among overweight and obese individuals cannot be ignored; using weight loss as a primary health indicator lacks scientific certainty and perpetuates weight-bias within health care.

The studies reviewed here provide a concerning picture about the ubiquity of weight bias among a wide range of health care providers. Weight bias, when present, is unethical and harmful to those health practitioners who purport to treat. It has been suggested that in order to maintain their ethical obligations, healthcare professionals should incorporate a compassionate and weight-neutral approach to their practice. However, in order to overcome weight bias within practice, the first step is to recognize and acknowledge bias. So, when you think about 'fat' individuals what are some of the words that first come to your mind?

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Fighting fat in families: The new "F word"

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Childhood obesity is increasing at an alarming rate worldwide, especially in developed countries. Between 1979 and 2004, the percentage of overweight and obese children in Canada rose from 15% to 26%.[1] Obesity in children is associated with increased risk of adulthood obesity and multiple health problems including cancer, type 2 diabetes and atherosclerosis.[2] All of these diseases create additional costs for an already overburdened health care system. Multiple explanations for childhood obesity have been proposed, including decreased physical activity, energy-rich diets, socio-economic status, education, genetics, and poor community design.[1,2] Many interventions targeting diet, physical activity and environment have been proposed, implemented, and proven mildly successful.[3] However, the family and the home are integral factors in childhood obesity that are still being largely overlooked.

Interventions targeting prevention of childhood obesity should focus on the primary caregiver and the home environment.[3,4] It is futile to remove soft drinks and sugary snacks from schools when those foods fill the cupboards at home. It is futile to make children engage in physical activity for an extra 30 minutes at school when they spend all their time at home sitting in front of screens. One family-based behavioural intervention showed a significant decrease in standardized body mass index in obese children after one year.[5] The intervention included food diaries, diet and exercise information sessions, and weekly goal setting by the family.[5] When parents participate in obesity reduction interventions, both the health of the child and the parent has been shown to improve.[4,5] Unfortunately, many parents are afraid to talk about the new F-word (fat) or any topics relating to being fat with their children.

A report by Statistics Canada in 2009 showed that low self-esteem is more common in children who are overweight or obese when compared to normal weight children.[6] Parents may think that they are protecting their children's self-esteem by avoiding the word fat. Unfortunately, children at school can be insensitive towards their peers. Obese children are more likely to be bullied than their normal weight counterparts.[7] Avoiding the subject of obesity at home may potentially result in increased damage to self-esteem, because children do not feel they can talk to their parents about their weight or about how they are treated at school. Bullied children with moderate to high family support are less likely to have depressive symptoms than children with low family support.[8] When parents choose to shy away from the word "fat", they are shutting down opportunities for open, honest and therapeutic communication.

One potential reason parents may hesitate to talk about being fat with their children is because they struggle with being overweight or obese themselves.[3] There is strong evidence suggesting that parental behavior and elevated parental weight can influence obesity risk in children[3,4] In contrast, one study found that the family environment per se did not play a significant role in weight status;[9] however, this study was conducted in school-aged children and therefore could not assess the influence of family during the initial years of development. The early years of life are when children have the greatest susceptibility to environmental factors.[4] Many risk factors associated with childhood obesity are related to the early life environment, like pre-pregnancy overweight mothers, high gestational weight gain, and not breastfeeding.[3] Other risk factors, especially exercise and eating behaviors, continue to be influential throughout childhood. These include low vegetable and fruit intake, high fast food consumption, high screen time and low physical activity levels.[4] Informing parents about the risk factors for childhood obesity and getting parents to engage their children on the topics of diet and exercise will greatly aid in obesity prevention.[5,10]

In an ideal world, all potential parents would be informed

about the factors contributing to childhood obesity prior to conception, but the large number of unplanned pregnancies makes this unrealistic. However, following conception, parents have multiple visits with physicians and other health care professionals. This is the perfect opportunity to educate parents about obesity prevention and encourage open dialogue about "fatness". A Finnish randomized control trial showed that infants whose mothers received individual diet and exercise counselling when the infant was between 2-10 months had significantly slower weight gain in the first year of life.[10]

In the past, the derogatory misuse of the word "fat" has led us to avoid its use entirely. Families should not avoid the word "fat" in their homes. Instead they should use the word fat constructively and respectfully to prevent the harmful physiological and psychological consequences of obesity. Families should discuss all aspects of fat: body fat, excessive fat, and healthy fat. Maybe once fat has been talked about, the conversation can progress to other important health topics like physical activity.

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Psychosocial correlates of obesity in adolescents: From prevention to intervention

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In 2005, the Public Health Agency of Canada reported a measured rate of 9.4% for obesity in youth between the ages of 12 and 17, with the prevalence of adolescents at risk for developing obesity also on the rise.[1] Adolescent obesity, defined as a body mass index (BMI) at the 99th percentile for the adolescents' age and sex, can be complicated by the co-morbidities of "adult" diseases, including obstructive sleep apnea, hyperlipidemia and type II diabetes leading to a vicious cycle of poor health and persistence of obesity into adulthood.[2] A recent review suggests that in the developed world the psychosocial effects of adolescent obesity such as mood disorders, low self-esteem and negative body image are highly detrimental.[3] Thus, in order to combat the population burden of childhood obesity, a more holistic approach is warranted, comprised of lifestyle modification supported by psychosocial-based intervention for overweight adolescents at risk of becoming obese.

The evidence regarding preventative strategies for childhood and adolescent weight gain have been systematically reviewed in the literature, suggesting that increased physical activity, healthy meal planning, reduced television watching as well as parental support, are key features for long-term weight control.[4] However, less is known regarding the additional role that psychosocial factors can play toward both the development of obesity and its influence on weight loss within already overweight adolescents. For example, an important aspect of managing adolescent obesity is coping with weight-related stereotypes and teasing, which may be internalized through feelings of low self-esteem and depression. Therefore, it is unclear whether such psychosocial vulnerabilities emerge as a result of weight gain or increase the risk of obesity onset. For example, a study by Haines et al. demonstrated that body dissatisfaction and concern with weight were significant predictors of obesity in male and female adolescents.[5] Specifically, they observed a significant correlation among boys between increased levels of depressive symptoms and prevalence of overweight.[5] Interestingly, these findings suggest that depression may play a causal role in the development of obesity, and is not exclusively an outcome.[6]

Additionally, Stice and colleagues reported that certain psychological risk factors predicted the emergence of obesity in adolescent girls.[6] Participants who engaged in harmful weight-loss behaviours such as vomiting or laxative misuse demonstrated a higher risk for obesity onset.[6] This correlation between weight loss efforts and consequent weight gain might seem counterintuitive. However, researchers suggest that weight-control behaviours may result in elevated metabolic efficiency or even increased binge eating, resulting in weight gain.[5]

Given these findings, prevention programs embedded within a psychosocial framework may be beneficial for adolescents at risk for developing obesity. For example, school-based focus groups and counseling aimed at promoting positive self-image, coping with teasing/bullying and preventing unhealthy weight control behaviors among adolescents of all body types could be initiated. Additionally, adolescents should be encouraged to engage in a variety of physical activities with the notion that exercise enhances endorphin secretion thereby reducing depression levels.[7]

Although BMI is considered as an imprecise measure of health risk, it may serve as a starting point for classification of obesity onset.[8] At present, no validated formula exists that can integrate BMI, psychosocial factors and familial history to determine which adolescents are at risk. Therefore, clinicians must utilize evidence-based judgment and evaluate the potential onset of obesity in both normal weight and overweight adolescents by assessing key areas such as parental obesity, sedentary behavior and family mental health history.[8]

Ideally, programs should be culturally sensitive and encourage adolescents to express their personal ideals of weight and beauty, which might serve as a social buffer, allowing adolescents to critically appraise media consumption and judge self-worth independent of appearance.[9] To illustrate, a recent peer-reviewed study found that strength of religious faith among Muslim women was inversely associated with body discontentment, self-objectification, and dietary self-control.[9] For these women, relationships were mediated by increased use of modest clothing and by reduced media consumption. On a cautionary note, the socio-cultural context of adolescents may only be beneficial if it does not promote attitudes of appearing attractive for the pleasure of others, or cultural practices such as uninterrupted fasting.

Overall, obesity is a multi-factorial illness, influenced by genetic, hormonal and environmental factors. Psychosocial factors alone cannot account for the alarming rates of obesity among adolescents, however, the current obesity epidemic in a fairly constant population illustrates that purely genetic factors are also not the chief culprit and that an integrated approach towards the prevention of pediatric obesity is preferable.[10]

Although treatments such as diet and exercise are effective interventions for managing adolescent obesity, they are a response rather than a solution to a growing health concern. Taking psychosocial variables into consideration may play a mediating role in reducing the rate of overweight adolescents as well as helping those who are overweight to be successful in their weight loss.

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Shame-based messaging and obesity campaigns: More harm than good?

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The profile of childhood obesity as a public health issue has increased dramatically in recent years, to the extent that the World Health Organization has identified it as one of the most serious public health challenges of the 21st century.[1] While a myriad of questions persist over what constitutes best practice in obesity prevention and management, many argue that any action taken to address the issue should evaluate the potential impact on weight bias and stigma. This need was driven home recently by a controversial media campaign in Atlanta, Georgia, produced by the not-for-profit organization Children's Healthcare of Atlanta. The 'Strong 4 Life' campaign features somber, overweight child actors in print ads and commercials stating messages such as "Big Bones Didn't Make Me this Way, Big Meals Did" and "It's Hard to be a Little Girl When You're Not".[2] The campaign constitutes a shock and awe advance in the "war" on obesity that is taking place in North America.

The Strong 4 Life campaign is defending their approach by suggesting that this "tough love" strategy will motivate parents and children to change their lifestyles.[3] Parents are directed to a campaign website that provides suggestions on how to discuss child body weight with a physician. Tips are also offered on changing behaviours associated with obesity. While there may be benefits in drawing parents into the site with a sensationalistic social marketing campaign, a message like "Stocky, Chubby, Chunky are Still Fat" suggests that negative responses towards obese individuals, children or otherwise, are appropriate. Compounding the ethical issues surrounding this approach is the fact that current research does not support the effectiveness of shame-based messaging in addressing weight and obesity; rather, these campaigns may do more harm than good by perpetuating stigma.

The harmful side effects of the stigmatization and shame associated with being obese are well documented, and extend to non-obese individuals who become preoccupied with body image.[4] An individual's experience with weight stigma can have a negative impact on weight loss, increase unhealthy weight control behaviours, and lead to depression, low self-esteem, and poor body image.[4] Stigmatization of obese individuals not only poses risks to psychological and physical health, but can also interfere with the implementation of effective obesity prevention measures.[5] In spite of this, the use of shame as a motivational tactic persists with regards to obesity. This might be due to the success of other similar public health media campaigns. For example, anti-tobacco campaigns that have featured negative emotional appeals have proven to be highly effective in changing behaviour.[6] However, tobacco is a high-risk activity for which the ideal solution is complete cessation. The task of addressing obesity through behavioural change is going to require a more nuanced approach that deals with the complexity it poses.

Many of our public health policies and interventions have traditionally focused on the individual by promoting an "eat less, move more" paradigm to address problems associated with body weight.[7] There is a growing trend, however, towards accepting obesity as a complex problem that is influenced by factors from the environmental, social and biological fields. Foresight, a UK policy group, has created an evidence-based model of obesity that highlights its complexity by clustering over 100 variables into seven sub-systems: physical activity environment, physiology, individual physical activity, social psychology, individual psychology, food consumption and food production.[8] If we begin to understand obesity as a system that is influenced by all of these factors and the relationships between them, then it is clear that addressing only individual behaviour will not create a significant impact on the system as a whole. Complex systems science suggests that there is no single solution to obesity, but that multiple interventions and strategies should be implemented with cooperation

and collaboration between many different sectors.[9] Part of the solution could involve reframing the focus of obesity interventions from obese individuals to a focus on health and wellness for all individuals in a population.[10]

Well-intentioned public health practitioners are eagerly seeking avenues to lessen the physical and psychosocial burdens suffered by many obese and overweight individuals. However, campaigns like Strong 4 Life present a potentially dangerous approach that could compound these health concerns. Singling out children for their weight in a mass public health appeal as a means of galvanizing parents may contribute to a cycle of shaming and stigma for the children themselves, while also perpetuating weight bias throughout society. Furthermore, decontextualizing individuals from the complex obesogenic environment in which they operate perpetuates a simplistic "eat less and move more" paradigm without addressing the social determinants that may influence decisions regarding food and exercise. Public health practitioners should therefore carefully weigh the perceived benefits against the potential risks associated with these types of interventions.

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Your kids, our future: Diverging perspectives of parents and society on the child body, obesity and responsibility

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Current trends suggest that global childhood obesity rates will continue rising.[1] These rates concern society because of their magnitude and economic impacts,[1] which cost Canada up to $4.3 billion yearly.[2] Childhood obesity in Canada has almost tripled since 1985, putting over 25% of its children into unhealthy weight categories.[3] Obesity interventions and prevention target children because they are a captive audience, learning habits that can promote healthy living and reduce the disease risks associated with chronic obesity.[1]

Using Uprichard's concept of 'being' and 'becoming',[4] I argue that parental and societal understanding of the child body differ, impacting the effectiveness of food-oriented childhood obesity interventions. First, this article explains that familial bonds cause parents to focus on their individual children in the present, or the 'being' child. Second, it discusses society's understanding of obesity as a problem requiring future-oriented and impersonal interventions, viewing children as the future, or the 'becoming' child. Because parents are responsible for governing their children's diets and routinizing healthy eating habits,[5] obesity interventions must recognize parental understanding of 'being' children to optimize nutrition-based obesity interventions.

Children's bodies are dichotomous entities, embodying present and future, the threatening and threatened. 'Being' children are social actors living in the *present* and reacting to their current environments. 'Becoming' children are *future* adults, or 'adults in the making' lacking the skills and features of the adults they will become.[6] Children's bodies are threatening because, without regulation, they lack the self-control or common sense, to practice effective self-governance required to make healthy food choices.[7] Children risk developing poor eating habits if left unregulated, leaving their bodies vulnerable to the development of chronic obesity and associated illnesses. Thus, it is precisely their vulnerability that renders them threatening. Without learning the healthy eating habits required to prevent obesity, children pose a threat of perpetuating unhealthy lifestyles through their own children in the future.

Childhood obesity's prominent societal discourses argue that parents are responsible for "curb[ing] and control[ing] their children's food choices and appetites".[5] This responsibility can conflict with parental instinct, fiscal ability, and/or legal requirements to provide nourishment and ensure that children gain weight with age.[8] Whether obesity results from wealth and over-provision, or from poverty and lack of access to healthy food,[3] parental feeding patterns are driven by the need to provide sustenance to their 'being' child.

Additionally, parental feeding choices are influenced by a fear of creating food and body-image diseases such as anorexia nervosa, bulimia, or secretive eating resulting from restrictive childhood relationships with food.[9] Parental perspectives on healthy food can be tenuous because fixating on 'correct' food choices can spark control-related eating disorders.[9] Some choose to restrict dietary choices overtly to promote healthy body weight. Others act neutral towards food choices in order to avoid creating eating disorders which can potentially harm the child.[9] The legal and instinctive requirements of parenting may benefit the 'becoming' child but parents' foremost concern is protecting their 'being' children.

Obesity is unhealthy for the 'being' child, but the 'becoming' child is more threatening in the society and government's view. Given rising obesity costs,[2] children are perceived as a potentially problematic generation of obese adults. However, we also view children's bodies as sites where we can intervene with healthy food programs preventing future medical and socio-economic suffering. Government

interventions such as healthy lunch program subsidies or legislation to ban school vending machines regulate child health behaviour, making their generation less threatening to the collective future's success. Viewing obesity as threatening to the future of children and society situates the body as an effect of disease, void of all individual characteristics apart from its relation to disease.[10] Obese bodies are thus, physical markers symbolizing future generations potentially dealing with chronic diseases associated with obesity.

In practice, public health treats bodies in this impersonal way because of its wide-reaching disease prevention and monitoring responsibilities. Government programs aiming to restrict children's diets are focused on the well-being of the collective future, what children *will be* (parents, workforce) instead of what they *are*.[4] Close familial connections with their 'being' children hinder parental conceptualization of their children as part of this impersonal collective future. These familial bonds cause parents to prioritize the happiness of the 'being' child.

The notion of 'being' and 'becoming' in relation to childhood obesity highlights how parenting decisions become difficult in the face of societal requests to restrict childhood food intake. This argument is limited to food restriction intervention and does not aim to deemphasize the role of larger structural barriers to child health (poverty, access to healthy food, etc.). Rather, it shows that different psychosocial perspectives of children's bodies impact obesity interventions. By exploring ways to develop interventions aligning with parental priorities of their 'being' children rather than emphasizing obesity reduction for a 'becoming' generation, we will enrich strategies to address the increasing rates[1] of childhood obesity.

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Using the built environment to combat childhood obesity

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Although it is more difficult to measure obesity among children than adults on account of their rapidly changing anthropometric indicators,[1] the prevalence of childhood obesity has risen significantly over the past few decades.[2] In fact, obesity among Canadian children aged 2-17 has increased 2.5 fold between 1978 and 2004.[2] These numbers are alarming, due to the fact that childhood obesity is associated with an increased risk of developing chronic diseases, such as coronary heart disease and diabetes in adulthood.[3] Improper nutrition and physical inactivity in children have been identified as key contributors to this ever growing epidemic.[3,4,5,6] An increasing body of evidence has revealed the role of the built environment in determining the exposure to these risk factors[3,5,6] As the rates of childhood obesity continue to rise, it is crucial that interventions are designed to address the key contributors to the problem.

On the simplest level, obesity is the result of an energy imbalance in which consumption exceeds expenditure.[6] There is no question that our physical environment influences this balance by either promoting or deterring healthy choices.[6] We can consider the "environment" to be anything that is "external to the individual", and the "built environment" to be "any aspects of a person's surroundings which are human-made or modified, as compared with naturally occurring aspects of the environment".[6] The built environment also encompasses a broader range of physical and social aspects which can influence our health. Some of these features include the cost and access of eating healthy, neighbourhood safety, as well as transportation opportunities.[6]

An increasing body of evidence is revealing that modern-day street layouts and accessibility to healthy foods have a significant impact on health.[3,5,6,7] Residents of areas that have access to supermarkets versus convenience stores or fast food restaurants tend to be healthier and have a lower prevalence of obesity.[7]

Similarly, accessibility to recreational facilities has been noted to significantly affect the daily physical activity levels of children.[5] While our current urban sprawl may not influence the development of childhood obesity as much as it does adulthood obesity[6,7] other essential aspects of this urbanization can determine how physically active children can be: the availability of institutions in which children can be physically active, and more importantly, their relative ease of access within the neighbourhood represent two fundamental features which limit the levels of physical activity a child can attain[5,6,7] Studies have shown that on average, residents of all ages living in sprawled communities were less likely to walk during their leisure time, weighed more, and had a higher prevalence of obesity.[3,7] Although these particular studies did not focus specifically on childhood obesity, it is thought that children have a greater susceptibility to the harmful aspects of their environments.[3] Thus, it is reasonable to anticipate similar results in studies assessing the affects of community spreading on a child's health.[3]

While it may be nice to imagine redesigning our more metropolitan neighbourhoods to be a little more inviting to children, this is clearly not a feasible remedy to the childhood obesity problem. Luckily, intervention strategies do not need to be as complicated as tearing down our homes and remodelling our communities. We can capitalize on the social aspects of the built environment to implement policies, which are relatively simple in practice but can have significant long-term benefits for children.[3] For example, a recent study assessing the effect of a school-based intervention program on the physical activity levels of elementary school children revealed that policies promoting physical activity among schoolchildren significantly increased their overall fitness levels.[8] In addition to enforcing more stringent physical education

programs with their school curricula, other relatively easy solutions could include supervising crosswalks nearby schools and recreational institutions.[5]

In the past, significant amounts of time and effort have been invested into public education strategies aimed at informing children and their families of the importance of living healthy lifestyles, as well as the dangers of noncompliance.[3] Evidently, as the growing obesity rates show, these campaigns have not been overly successful.[3] The Canadian Society for Exercise Physiology has recently released the world's first evidence-based sedentary activity guidelines for children and youth in an attempt to break this indolent cycle.[9] Lifestyle changes, which are conceptually very easy but difficult to complete in practice, are the only solution to this ever-growing problem. In the long run, getting healthier will not be easy, but we cannot give up because it will definitely be worthwhile.

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Nipping it in the bud: The role of primary care in early prevention and management of childhood obesity

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The prevalence of obesity in Canadian children has more than doubled in the last few decades, putting Canada in the midst of a childhood obesity epidemic.[1] Unfortunately, obesity in childhood is often carried into adulthood and can become a significant risk factor for common chronic diseases including hypertension, coronary heart disease and several forms of cancer.[1] Perhaps more alarming is the consequent emergence of type 2 diabetes (T2D), previously labeled an adult disease, in the younger age groups; in fact, nearly all children who are diagnosed with T2D are overweight or obese.[2] Given the many downstream co-morbidities associated with childhood obesity, efforts to prevent and manage it are of utmost importance.

Not surprisingly, although some individuals have a genetic predisposition to obesity, the causes are not only biological, but also social.[1] Sociological factors, such as ethnicity, socioeconomic status, and area of residence, play important roles in determining the risk of obesity.[1] For instance, a higher prevalence of obesity is observed in aboriginals compared to non-aboriginals.[1] Thus, it is prudent to reason that the success of any obesity prevention and management strategy is dependent on its ability to address both intrinsic patient characteristics and external environmental factors that affect the disease risk.

Given the frequent contact between a family physician, pediatrician or nurse practitioner and parents with children, primary care has emerged as a promising avenue for the development of preventative care and early intervention strategies.[3] Primary care providers have a unique opportunity to address childhood obesity because they have longitudinal access to patient histories that will assist in the early identification of at-risk individuals, which often yield greater success in subsequent treatment.[4] In turn, physicians who are successful in referring their patients to effective treatment programs will positively reinforce their screening behaviours.[4] One can also imagine that primary care providers are more likely to be equipped to develop rapport and encourage compliance in their patients through a holistic understanding of the different cultural values and socioeconomic status within the region they serve. Currently, however, studies show that primary care providers lack the knowledge and skills to assess and manage childhood obesity.[5] What this necessitates is further research to facilitate the development of systematic, evidence-based primary care strategies to guide physicians through the diagnosis, treatment and prevention of obesity in children.

Practice based research networks (PBRNs) may provide a much-needed solution. PBRNs are groups of healthcare providers or medical clinics typically situated in non-academic environments that are networked for the purposes of evaluating and advancing healthcare practices in communities, including improving disease screening and prevention strategies.[3] Although standardized tools for assessing the effectiveness of PBRNs are yet to be established,[6] PBRNs can accomplish many benefits for the medical field, policy-makers and the public in the battle against childhood obesity. They enable family physicians to be principal investigators, thereby allowing them to contribute to cutting-edge research, to practice, learn and reflect in order to improve patient care.[7] They also promote collaboration between primary care providers and researchers, allowing for the continual evolution of study protocols that arise from experiences as front-line care providers.[7] In addition, they can encourage children, families and other members of the community (teachers, counselors, etc.) to be active participants in achieving the goal of building healthier communities, a feature often not available to traditional academic centre-based research.[3] Ultimately, PBRNs serve to assemble an evidence base for the development of pragmatic, primary care prevention and management strategies that community healthcare

providers themselves can incorporate into their everyday practice. More simply, PBRNs are the translational bridge that fills the gap between bench and bedside.

Recently, the Public Health Agency of Canada, in partnership with the College of Family Physicians of Canada and the Canadian Institute for Health Information, has committed to a 5-year contribution agreement to continue the development of the Canadian Primary Care Sentinel Surveillance Network (CPCSSN).[8] CPCSSN was founded to enable the monitoring of chronic diseases and serves as a resource for primary care research;[8] it represents the first step towards improving primary care practices across Canada. Unfortunately, local PBRNs, such as TARGetKids!,[9] a Toronto-based pediatric PBRN specifically addressing childhood obesity, must still rely on funding from external sources or operating grants from the Canadian Institutes of Health Research,[10] which is unsustainable over the long term.

Given the potential for PBRNs to truly improve the health status of populations, we need to seriously consider them as frontrunners in the race towards childhood obesity reduction. Our efforts need to be focused on cultivating these "laboratories of primary care",[7] especially since the majority of clinical and preventative care is delivered in these settings. If we are determined to build healthier Canadians, we must begin early and nip obesity in its bud.

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