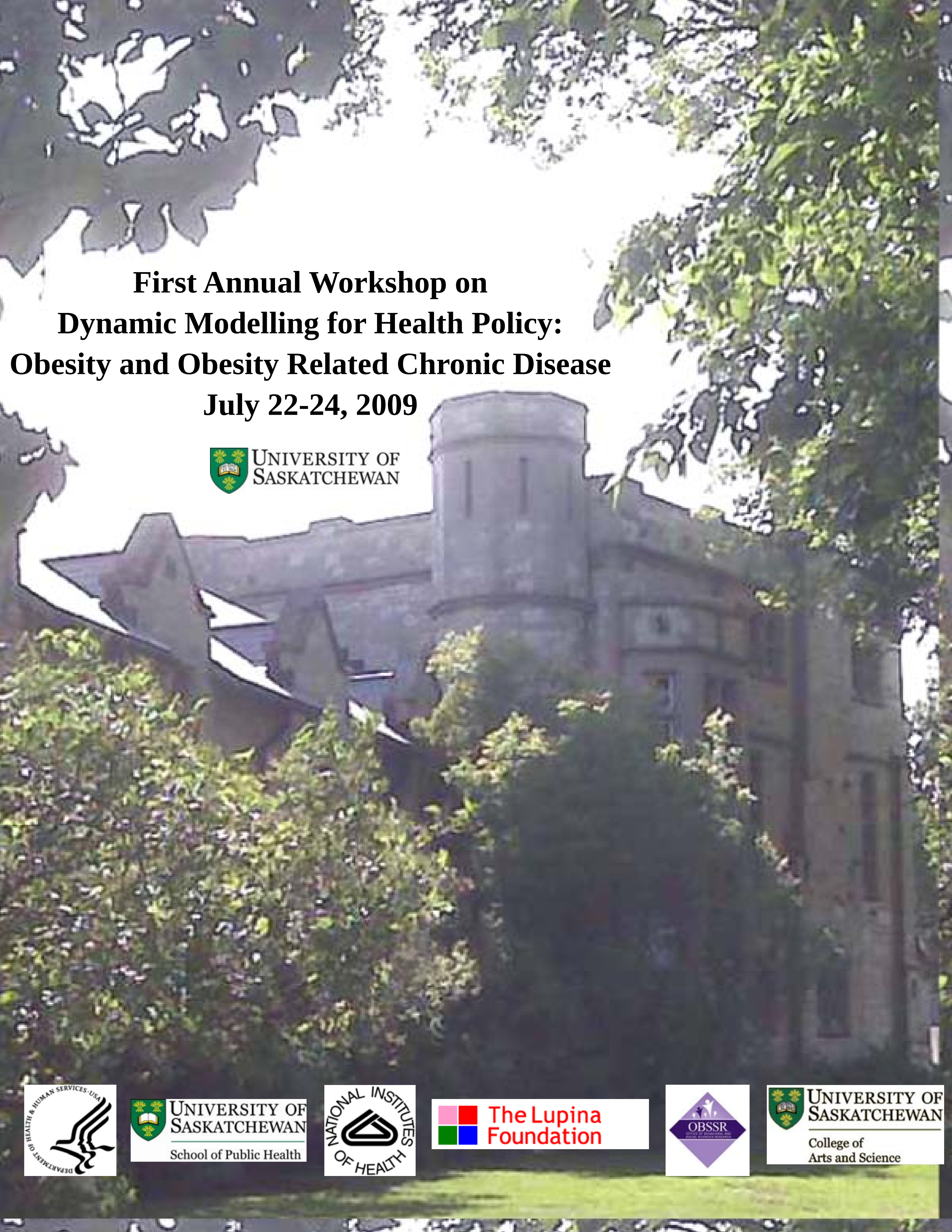
First Annual Workshop on Dynamic Modelling for Health Policy: Obesity and Obesity Related Chronic Disease

July 22-24, 2009

University of Saskatchewan



Department of Health & Human Services · USA

University of Saskatchewan
School of Public Health

National Institutes of Health

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We would like to offer special thanks to our co-sponsors, speakers, volunteers & workshop coordinators

Co-Sponsors

The Lupina Foundation
National Institutes of Health, Office of Behavioral & Social Science Research
University of Saskatchewan
University of Saskatchewan School of Public Health
University of Saskatchewan Obesity Research Group
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Speakers & Panelists

Azadeh Alimadad	*Simon Fraser University*
Tarek Abdel-Hamid	*Naval Postgraduate School*
Roland Dyck	*University of Saskatchewan*
Nancy Edwards	*CIHR IPPH*
Meenakshi Fernandes	*Pardee RAND Graduate School*

Diane Finegood	*Simon Fraser University & Canadian Partnership Against Cancer*
Ross Hammond	*Brookings Institution*
Kristen Hassmiller Lich	*The University of North Carolina at Chapel Hill*
Terry Huang	*NICHD*
Ozge Karanfil	*Simon Fraser University*
Peter Katzmarzyk	*Pennington Biomedical Research Center*
Lisa Lix	*University of Saskatchewan*
Scott Leatherdale	*Cancer Care Ontario*
Patricia Mabry	*NIH OBSSR*
Regan Mandryk	*University of Saskatchewan*
Nathaniel Osgood	*University of Saskatchewan*
Laura Rosella	*ICES/University of Toronto*
Gary Sacks	*Deakin University*
Kevin Stanley	*University of Saskatchewan*
Mona Vajihollahi	*Simon Fraser University*
Y. Claire Wang	*Columbia University*
Peter Warrian	*Lupina Foundation*

Volunteers	***(University of Saskatchewan Program Affiliation)***
Irini Abdel-Mallek	*MPH*
Amy (Yu) Gao	*Computer Science*
Ying Jiang	*Biostatistics*
Yiqing Liu	*Computer Science*
Aziza Mahamoud	*MPH*

Sabuj Sarker	*Biostatistics*
Yan Yao	*Community Health and Epidemiology & Jilin Univ.*
Karen Yee	*MPH*
David Vickers	*Interdisciplinary*
Jin Zhang	*Computer Science*

Workshop Logistics Coordinator

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Planning Co-Chairs

Patricia Mabry	*NIH OBSSR*
Nathaniel Osgood	*University of Saskatchewan*

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AGENDA

Day 1: July 22, 2009

4:00 pm **Welcome from Sponsors & Organizers and Overview of Workshop**
Peter Warrian, Ph.D. (Lupina Foundation)
Nathaniel Osgood, Ph.D. & Patty Mabry, Ph.D. (Workshop Organizers)

4:30 pm **Keynote Address**
Shifting the Paradigm: How systems thinking can change the way we address the obesity epidemic
Diane Finegood, Ph.D.
Simon Fraser University & Canadian Partnership Against Cancer

5:30pm **Session 1: Understanding Obesity Trends**

The Obesity Epidemic: An Historical Perspective from North America
Peter Katzmarzyk, Ph.D.
Pennington Biomedical Research Center

Obesity Prevention in Australia
Gary Sacks, Ph.D. Candidate
Deakin University

7:00pm **Adjournment** (Optional Dinner, 2nd Avenue Grill)

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Day 2: July 23, 2009

7:30 am **Breakfast** (Outside Edwards School of Business 18)

8:00 am **Session 2: Individual-Level Models**

Thinking in Circles about Obesity
Tarek Abdel-Hamid, Ph.D.
Naval Postgraduate School

A Complex Systems Approach to Understanding and Combating the Obesity Epidemic
Ross Hammond, Ph.D.
Brookings Institution

9:45 am Health Break

Energy Gap Metrics for Understanding Population Weight Shifts
Claire Wang, M.D., Sc.D.
Columbia University

Using a population-based risk tool to support health planning for diabetes in Canada
Laura Rosella, MHSc., Ph.D.
Institute for Clinical & Evaluative Sciences & University of Toronto

School Health Action, Planning and Evaluation System (SHAPES)
Scott Leatherdale, Ph.D.
Cancer Care Ontario

12:15 pm **Lunch** (Faculty Club)

1:45pm **Session 3: Obesity-Related Disease Burden**

The Role of Gestational Diabetes in the Epidemic of Type 2 Diabetes Among Saskatchewan First Nations People
Roland Dyck, M.D.
University of Saskatchewan

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Day 2: July 23, 2009 continued

	Exploring the Intra- or inter-generational Impact of Gestational Diabetes on Type 2 Diabetes: Results from the Gestational Diabetes Population Model *Nathaniel Osgood, Ph.D.* *University of Saskatchewan*
	A System Dynamics Model of Cardiovascular Disease Risk: Identifying Policy Levers in a Local Context *Patty Mabry, Ph.D.* *Office of Behavioral & Social Science Research, United States National Institutes of Health (OBSSR)*
3:30 pm	Health Break
	Estimating the Costs of Childhood Obesity Over the Lifecycle *Meenakshi Fernandes, Ph.D. Candidate* *Pardee RAND Graduate School*
	Tobacco, diabetes, HIV, and TB: The importance of dynamic modeling when chronic and infectious diseases interact (work in progress) *Kristen Hassmiller Lich, Ph.D.* *University of North Carolina Chapel Hill*
	Outcomes Exercise: Modelling Gaps *Terry Huang, Ph.D., M.P.H.* *The Eunice Kennedy Shriver National Institute of Child Health and Human Development, United States National Institutes of Health (NICHD)*
6:00 pm	**Adjournment** (Optional Dinner, Calories Restaurant)

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Day 3: July 24, 2009

7:30 am **Breakfast** (Outside Edwards School of Business 18)

8:00 am **Session 4: Sources of Empirical Data**

A Valuable Tool for Modeling Health Service Utilization and Outcomes for Chronic Disease
Lisa Lix, Ph.D., P.Stat.
University of Saskatchewan

Integrating Monitoring into Everyday Activities
Kevin Stanley, Ph.D. & Regan Mandryk, Ph.D.
University of Saskatchewan

10:00 am Health Break

Outcomes Exercise: How institutions could better support modelling

Funding Panel
Patty Mabry, Ph.D. (NIH OBSSR)
Terry Huang, Ph.D., M.P.H. (NICHD)
Peter Warrian, Ph.D. (Lupina Foundation)
Nancy Edwards, R.N., Ph.D. (Canadian Institutes of Health Research, Institute for Population and Public Health)

11:45 pm **Lunch** (Faculty Club)

1:00pm **Session 5: Student Work in Progress**

A system dynamics model of body weight regulation and obesity
Ozge Karanfil, Ph.D. Student
Simon Fraser University

How Maxhist hypothesis shows that weight transitions are not Markovian
Azadeh Alimadad, Ph.D. Candidate
Simon Fraser University

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Day 3: July 24, 2009 continued

	Agent-based models reveal the interplay of physical activity and environment *Mona Vajihollahi, Ph.D. Candidate* *Simon Fraser University*
2:30 pm	**Outcomes Exercise: Areas where modelling could better serve public health needs**
3:15 pm	**Closing Remarks & Reflections**
3:30 pm	**Adjournment**
6:00 pm	Optional Dinner, Truffles Bistro

First Annual Workshop on Dynamic Modelling for Health Policy: Obesity & Obesity Related Chronic Disease

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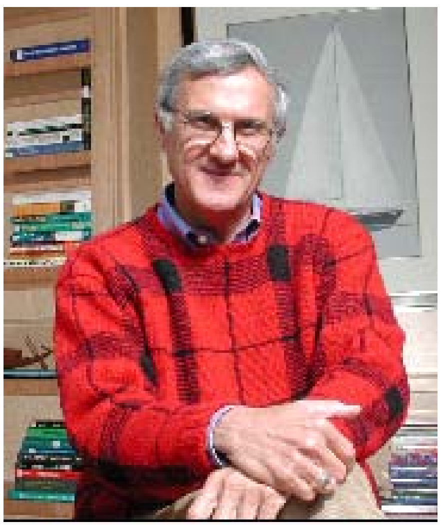
Speaker Photos & Biographical Sketches

Azadeh Alimadad, Ph.D. Candidate
Simon Fraser University

Ms. Alimadad completed her B.Sc. in Mathematics in Iran and holds an M.Sc. in Biostatistics from Carleton University. She has started Ph.D. studies in faculty of health sciences at SFU. Her thesis project is "Modelling the impact of gradual sodium reduction on cardiovascular disease".



Tarek K. Abdel-Hamid, Ph.D.
Naval Postgraduate School

Tarek K. Abdel-Hamid has been a Professor of Information Sciences and System Dynamics at the Naval Postgraduate School since 1986. Dr. Abdel-Hamid received his Ph.D. in Management Information Systems and System Dynamics at MIT, and the Master's in Engineering Economic Systems at Stanford. Prior to joining NPS, he spent two and a half years at the Stanford Research Institute as a senior IT consultant. Dr. Abdel-Hamid is the coauthor of Software Project Dynamics: An Integrated Approach (Prentice-Hall, 1991), for which he was awarded the 1994 Jay Wright Forrester Award. His latest book, Thinking in Circles about Obesity: Applying Systems Thinking to Weight Management, will be published by Springer in August 2009. In addition to his two books, he has authored or coauthored more than 50 papers on system dynamics and its applications.

When not teaching or writing, Tarek is usually on the water. With his wife, Nadia, he won first place in the 1999 San Francisco to Santa Barbara Yacht Race (Cruise Division) on their traditional Alden sloop.

Roland Dyck, M.D.
University of Saskatchewan

Roland Dyck is a Professor in the Department of Medicine, University of Saskatchewan. His research is directed at describing and understanding the epidemic of T2DM among Saskatchewan First Nations with a particular focus on the role of diabetic pregnancies.

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Meenakshi Fernandes, Ph.D. Candidate
Pardee RAND Graduate School (PRGS)

Meena Fernandes is a 4th year Doctoral Fellow in Policy Analysis at the Pardee RAND Graduate School (PRGS) and an Assistant Policy Analyst at RAND. Her interests are broadly related to the social and economic determinants of population health. Topics she has worked on include childhood obesity, food security, neighborhood effects and cross-country comparisons of health. Her dissertation assesses the impact of school nutrition and physical activity policies on child health. She is the 2009 recipient of the Judy K Black Award from the American Academy of Health Behavior that recognizes early-career health behavior research that is innovative and that makes an important contribution to science or practice. Prior to joining PRGS she was an Assistant Analyst in the Health and Human Resources Division at the Congressional Budget Office and a consultant at the World Bank. Meena holds an BA with honors in Economics from The University of Chicago and an MPhil in Policy Analysis from PRGS.

Diane Finegood, Ph.D.
School of Biomedical Physiology and Kinesiology
Simon Fraser University

Dr. Diane Finegood was recently appointed Executive Director of The CAPTURE Project, an initiative of the Canadian Partnership Against Cancer.

She is a Professor in the School of Biomedical Physiology and Kinesiology at Simon Fraser University and formerly served the Canadian Institutes of Health Research as the inaugural Scientific Director of the Institute of Nutrition, Metabolism and Diabetes from 2000-2008.

Dr. Finegood received the 2006 Canada's Top 100 Women Award and the 2008 Frederick G. Banting Award from the Canadian Diabetes Association. She received her doctoral degree in physiology and biophysics and has bachelor's and master's degrees in engineering.

Ross Hammond, Ph.D.
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Dr. Ross A. Hammond is a Fellow in Economics Studies at The Brookings Institution, where he is a member of the Center on Social and Economic Dynamics. His primary area of expertise is modeling complex dynamics of social, economic, and political systems using mathematical and agent-based computational methods. His current research topics include behavioral epidemiology, obesity, trust, corruption, and ethnocentrism.

Hammond received his B.A. from Williams College, and his Ph.D. from the University of Michigan. He has authored or co-authored numerous scholarly publications, on a wide range of topics, in journals such as Proceedings of the National Academy of Sciences, Journal of Conflict Resolution, Theoretical Population Biology, Evolution, Preventing Chronic Disease, and Complexity. Hammond has previously been the Okun-Model Fellow in Economics at the Brookings Institution, an NSF IGERT IDEAS Fellow in the Center for the Study of Complex Systems at the University of Michigan, a Visiting Scholar at The Santa Fe Institute, and a Consultant at PricewaterhouseCoopers LLP.

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Dr. Terry Huang is Director of the Obesity Research Strategic Core at the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), National Institutes of Health (NIH). Dr. Huang plays a major role in developing new research directions and funding priorities in the area of pediatric obesity at the NICHD and across the NIH. He is currently leading an agenda on global multilevel research in pediatric obesity and has special interest in society-biology interactions in obesity and chronic disease, multilevel prevention strategies, international health, pediatric metabolic syndrome, fetal and childhood antecedents of obesity and related disorders, and the translation of science to policy in obesity and chronic disease prevention. Dr. Huang is Fellow of The Obesity Society (TOS) and Councilor on the Pediatric Obesity Section of TOS. In addition, he serves on the 5-member Senior Leadership Group of the NIH Obesity Research Task Force and represents the NICHD nationally and internationally on panels related to pediatric obesity. Dr. Huang also serves on the steering committee of the National Collaborative on Childhood Obesity Research (NCCOR) and as a senior scientific advisor to childhood obesity programs funded by the Robert Wood Johnson Foundation. Dr. Huang is a graduate of the University of Southern California (PhD, Preventive Medicine; MPH, Epidemiology and Biostatistics) and McGill University (BA, Psychology). Prior to joining

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	**Ozge Karanfil**, Ph.D. Student Simon Fraser University Özge is a PhD student in the Department of Biomedical Physiology and Kinesiology at Simon Fraser University. As an undergraduate she studied Industrial Engineering and has completed two masters' degrees, one in Industrial Engineering with a specialization in System Dynamics and the other in Physiology, from McGill University. She is currently working on building a system dynamics model to explain the underlying structure of human obesity and its complex interactions between physiology and behavior. Her research interests include dynamic modeling for policy analysis, complex systems modeling related to chronic disease, organ-system level interactions, multi-scale modeling and creation of learning environments.
	**Peter T. Katzmarzyk**, Ph.D. Pennington Biomedical Research Center Dr. Katzmarzyk is currently a Professor and the Associate Executive Director for Population Science at the Pennington Biomedical Research Center in Baton Rouge, Louisiana, USA. He also holds the Louisiana Public Facilities Authority Endowed Chair in Nutrition. He obtained a PhD in Exercise Science from Michigan State University in 1997, and pursued post-doctoral education at Laval University in 1998. Dr. Katzmarzyk began his career at York University in Toronto where he was promoted to Associate Professor before moving to Queen's University in 2002 and the Pennington Biomedical Research Center in 2007. His main research interest is the epidemiology and public health impact of obesity and physical inactivity, and determining the relationships between physical activity, physical fitness, obesity and related disorders such as metabolic syndrome, cardiovascular disease and diabetes. Dr. Katzmarzyk has published his research findings in more than 190 scholarly journals and books, and regularly participates in the scientific meetings of several national and international organizations. He is currently an editorial board member for the *International Journal of Pediatric Obesity, Journal of Physical Activity and Health, and Metabolic Syndrome and Related Disorders.*

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Dr. Scott Leatherdale is a Scientist and Research Chair in the Department of Population Studies and Surveillance at Cancer Care Ontario. He also has appointments as an Associate Professor in the Dalla Lana School of Public Health at the University of Toronto and Health Studies and Gerontology at the University of Waterloo, and as a Scientist with the Canadian Cancer Society's Centre for Behavioural Research and Program Evaluation (CBRPE). Dr. Leatherdale is also a board member of the Institute Advisory Board for the Institute of Cancer Research (IAB-ICR) of the Canadian Institutes of Health Research (CIHR) and an advisory board member of the Canadian Cancer Society Research Institute (CCS-RI).

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Lisa Lix is Associate Professor and Centennial Chair, School of Public Health and Associate Member, Department of Mathematics and Statistics at the University of Saskatchewan. Her research interests include chronic disease case ascertainment methods for administrative data, data quality, analysis of repeated measures/longitudinal data, and multivariate statistics. Lisa collaborates widely on projects about population health and the association between chronic disease and quality of life. Her research is funded by CIHR. She has served on the Board of the Statistical Society of Canada since 2005 and holds the designation of Professional Statistician (P.Stat.).

Patricia L. Mabry, Ph.D.
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Dr. Mabry is a behavioral scientist and Senior Advisor in the Office of Behavioral and Social Science Research (OBSSR) at the National Institutes of Health. She currently oversees research focusing on interdisciplinary science (including initiatives under the NIH Roadmap), systems science approaches to addressing public health problems, and connective information technology (cyberinfrastructure) to enhance collaboration and coordination among behavioral, social and population scientists with a goal of improving population health. Dr. Mabry earned her Ph.D. in Clinical Psychology from the University of Virginia, Since then she has worked in small business, academia, and government, and her post-doctoral experiences fall into several broad categories: conducting original intervention research for tobacco cessation, providing counseling and psychological services to individuals and couples, teaching behavioral aspects of medicine to medical students, writing NIH Small Business Innovation Research (SBIR) grant applications, and programmatic support to NIH.

Dr. Regan Mandryk, Ph.D.
University of Saskatchewan

Assistant Professor Dr. Regan Mandryk is a member of the Department of Computer Science at the University of Saskatchewan. Her multidisciplinary background enabled her innovative research on using physiology to mathematically model emotion during computer game play. Her research interests include human computer interaction, including persuasive technologies for encouraging healthy behaviors.

Nathaniel Osgood, Ph.D.
Department of Computer Science
University of Saskatchewan

Nathaniel Osgood is an Assistant Professor in the Department of Computer Science and Associate Faculty in the Department of Community Health & Epidemiology, School of Public Health and Division of Bioengineering at the University of Saskatchewan. Dr. Osgood's work focuses on providing tools to inform understanding of population health trends and health policy tradeoffs. This work includes both methodological and applications components. The methodological components seek to advance the art of model building through improved formalisms, algorithms, software tools, and design guidelines. On the application side, Dr. Osgood works closely with cross-disciplinary teams on several team-based projects applying Agent-Based modeling and System Dynamics to address urgent public health challenges in both the chronic and infectious disease areas. His work has a particular focus on the health of Aboriginal peoples.

Laura Rosella, MHSc., Ph.D.
Institute for Clinical Evaluative Sciences
University of Toronto

Laura Rosella received a Masters in Epidemiology in 2005 and completed her PhD in Epidemiology in 2009, both at the Dalla Lana School of Public Health at the University of Toronto. She has trained at a variety of research institutions including Cancer Care Ontario, Hospital for Sick Children, the Manitoba Centre for Health Policy and the Institute for Clinical Evaluative Sciences (ICES). Her thesis work was focused on developing tools to manage and support the public health management of diabetes and obesity in the population. Her primary research interests include health services research, population and public health, and biostatistical methods. In addition to her research activities, she is involved in graduate teaching of biostatistics and epidemiology at the University of Toronto.

Gary Sacks, Ph.D. Candidate
Deakin University

Gary is a PhD candidate at Deakin University in Melbourne, Australia. In conjunction with his supervisor, Professor Boyd Swinburn, Gary's research focuses on policies for obesity prevention and, particularly, the relative cost-effectiveness of policy interventions in the food environment. As part of his PhD, Gary has undertaken research placements at Oxford University in 2008 and Harvard University in 2009. Prior to undertaking his PhD, Gary worked as a management consultant having completed degrees in economics and information systems.

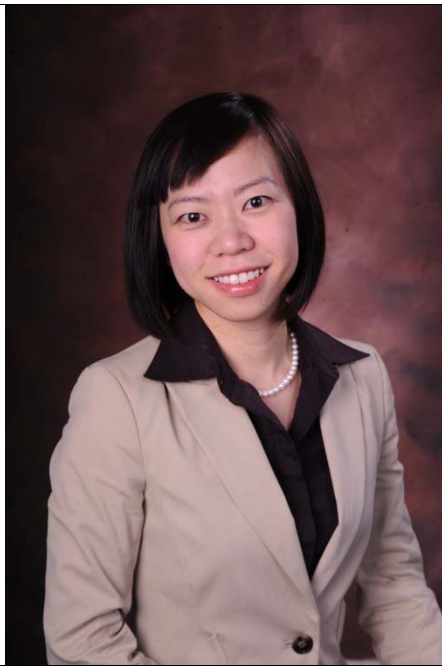
Kevin Stanley, Ph.D.
University of Saskatchewan

Kevin Stanley is an Assistant Professor in Computer Science at the University of Saskatchewan. His primary research interest is in sensors and sensor systems, including the design, fabrication and integration of sensor systems and the collection, analysis and utilization of collected sensor data. His primary interest in health is ubiquitous and sensor-based data acquisition systems. He also has an interest in ubiquitous games for health and health monitoring.

Mona Vajihollahi, Ph.D. Candidate in Computing Science
Simon Fraser University

Mona Vajihollahi is a PhD candidate of Computing Science at SFU. Her background is in formal aspects of software technology and novel applications of agile formal methods. Her research focus is on the application of computational modeling and formal analysis techniques in interdisciplinary studies of complex systems. She has collaborated with the Institute of Canadian Urbane Research Studies (ICURS) and RCMP "E" division in order to build simulation models for crime prevention and prediction. Since September 2008, she has been collaborating with the Chronic Disease Systems Modelling Lab at SFU. She is interested in developing computational models that can be used as decision support tools for systematic analysis of chronic diseases and related health policies.

The Lupina Foundation
University of Saskatchewan School of Public Health
University of Saskatchewan College of Arts and Science



Y. Claire Wang, M.D., Sc.D.
Mailman School of Public Health
Columbia University

Y. Claire Wang is Assistant Professor at Columbia University, Mailman School of Public Health, Department of Health Policy and Management. Her research interests surrounds the theme of using mathematical models as the metric to integrate epidemiology and demography to inform policy-making. Her present research focuses on the obesity epidemic and their health and economic impact, disparity, and cardiovascular disease prevention.

Presentation Titles & Abstracts

Speaker	Title & Abstract
Tarek K. Abdel-Hamid, Ph.D. Naval Postgraduate School	*Thinking in Circles about Obesity* Human energy and weight regulation is a complex of nested feedback processes at multiple levels—the homeostatic processes at the physiologic level, between the physiologic and the behavioral, and between people and their external environment. While our bodies work in circles, people tend to think in straight lines. A perfect example of straight-line-thinking is the energy balance equation (EBE)—the staple energy calculus by which dieters (as well as many health care professionals) explain weight gain and predict treatment outcomes. It is linear, open-loop, unbounded (taking weight loss projections to absurd values)... and can be way off. It is truly a legacy of earlier times when we were computationally poor. In this talk, I argue for and aim to demonstrate the feasibility and utility of a new generation of dynamic feedback tools that support interaction and customization for personal weight management.
Azadeh Alimadad, Ph.D. Candidate Simon Fraser University	*How Maxhist hypothesis shows that weight transitions are not Markovian* The National Longitudinal Survey of Youth 1997 (NLSY97) is used to show how individuals transitioned between different BMI statuses. In this talk we will demonstrate that the changes in obesity status over time do not satisfy the Markov assumption, and is therefore the basic Markov model is invalid. We introduce a new model (the Maxhist Model) to test our hypothesis regarding probabilities of particular patterns of weight changes over time in the population. Our Maxhist hypothesis states that an individual's most probable weight class two years into future is determined by their maximum historical weight class.
Roland Dyck, M.D. University of Saskatchewan	*The Role of Gestational Diabetes in the Epidemic of Type 2 Diabetes Among Saskatchewan First Nations People* Saskatchewan First Nations people (FN) are experiencing an epidemic of type 2 diabetes (T2DM) which is characterized by an excess diabetes burden among FN women. A systematic series of epidemiologic studies carried out in Saskatchewan since 1991 suggest that gestational diabetes (GDM) plays a significant role in this epidemic since it is a predictor for T2DM in affected women and a possible risk

	factor for T2DM in their offspring. These intra- and inter-generational consequences of GDM may contribute to increasing rates of T2DM in FN and other populations, provide insights into mechanisms underlying T2DM, and offer unique opportunities for primary prevention of T2DM.
Diane Finegood, Ph.D. Simon Fraser University & Canadian Partnership Against Cancer	*Shifting the Paradigm: How systems thinking can change the way we address the obesity epidemic* **(Keynote Address)** Conceptual models of obesity have evolved from early descriptions which suggested that obesity is simply a result of energy imbalance to ecological models which acknowledge the importance of environmental factors both proximal and distal to the individual. Recently, the Foresight Programme of the UK Government Office of Science developed a conceptual model which illustrates how more than 100 variables from 8 clusters including food production, social psychology and the physical activity environment interact in a complex system where obesity is an emergent property. The Foresight system map is the first to illustrate the causes of obesity as complex, not just complicated, with the dominant feature being the interconnections and feedback loops between variables. We used social network analysis software (Pajek) to examine the connections between variables by cluster and to produce a reduced system map. The reduced map helps unpack current perceptions about the strength of influence of food production variables on food consumption and the lack of a direct effect of food consumption on food production. Feedback loops have from 2 to 17 variables. Variables with the largest number of inputs are primarily from clusters at the level of the individual while variables with large numbers of outputs arise from more distal clusters. Given the complexity of the factors that give rise to obesity, it is not surprising that recent efforts to identify actions to address obesity and chronic disease give rise to long lists that include many sectors and require the engagement of many actors. In an effort to get a better sense of the "big picture" we sorted several sets of actions data into an Intervention Level framework adapted from D. Meadows "Places to Intervene in Complex Systems" (Sustainability Institute, 1999). Actions sorted into our 5 level framework show a similar distribution with the dominant level being structural elements followed by the structure as a whole. Paradigms and goals are less often described, and there is an apparent gap at the level of feedback and delays. Together these analyses illustrate that systems thinking, conceptual models and systems science tools can help to reframe our approach to solving the complex problem of obesity.

Ross A. Hammond, Ph.D. The Brookings Institute	*A Complex Systems Approach to Understanding and Combating the Obesity Epidemic* The obesity epidemic has become a major public health concern, with a scope and scale that motivate an urgent need for well-crafted policy interventions. Yet several attributes of the epidemic make it especially challenging to study and to combat. I will show how these challenges are characteristic of a complex adaptive system, and discuss the implications for both science and policy design for obesity. I will discuss modeling techniques well suited for multi-level, cross-disciplinary study of obesity, with a particular focus agent-based computational modeling (ABM). I will then outline the direction my own research on obesity is taking, using these techniques.
Ozge Karanfil, Ph.D. Student Simon Fraser University	*A system dynamics model of body weight regulation and obesity* The growing interest in body weight regulation has culminated in the growth of simulation models that are employed as a tool to investigate this complex system, and as a means for evaluating hypotheses concerning the induction and maintenance of obesity. The purpose of this modeling study is to develop a dynamic representation of our body weight regulatory system in normal and obese states, and to examine the interactions between the body composition and food intake regulation to see their effects on body weight maintenance.
Peter Katzmarzyk, Ph.D. Pennington Biomedical Research Center	*The Obesity Epidemic: An Historical Perspective from North America* Obesity is now a prevalent condition in many developed and developing countries. Although there are differences in the prevalence of obesity across socio-economic strata and between gender, age and ethnic groups, the increases that have been observed in recent decades have occurred in virtually all sub-groups of the population. The purpose of this presentation is to provide an historical perspective on the obesity epidemic, focusing on trends in North America from the early 1950's to the present day.
Scott Leatherdale, Ph.D. Cancer Care Ontario	*School Health Action, Planning and Evaluation System (SHAPES)* What is SHAPES? SHAPES is designed to provide data that will serve as evidence for population-based intervention planning, evaluation, and field research related to youth. In addition,

	schools and community groups can use SHAPES as a resource for evaluating interventions by examining the effects of these interventions on youth attitudes and behaviours. This system has been developed as a modular local data collection and feedback system. A machine-readable questionnaire is used to collect data and a timely school-specific feedback report is generated and sent back to the school. SHAPES currently consists of four modules: 1) Physical Activity Module *also measures obesity 2) Smoking Behaviours Module 3) Healthy Eating Module 4) Mental Fitness Module Each SHAPES module consists of three elements: 1) a short, low-cost, machine readable questionnaire validated for students in grades 5-12, 2) a school administrator survey to assess school policy, programs, and facilities, 3) a school-specific computer-generated feedback report for each school. The rationale for developing SHAPES was to (a) facilitate and stimulate the development, planning, and evaluation of interventions and policies related to health behaviours within schools, (b) enable high quality research to be conducted in real world settings , (c) minimize the burden on school personnel and students, and (d) maximize value to schools and stakeholders. We envision SHAPES facilitating a new generation of evidence-driven interventions for youth.
Lisa Lix, Ph.D., P.Stat. School of Public Health	*Administrative Data: A Valuable Tool for Modeling Health Service Utilization and Outcomes for Chronic Disease* Administrative health data, which are collected for purposes of health system monitoring and financial management, are a rich resource for chronic disease research. These data produce results that are population-based, can be used to address a variety of policy-relevant research questions, and are relatively inexpensive to access compared to primary data. This talk will describe issues that affect the use of administrative data in health service utilization and outcomes modeling: data quality, comparability across jurisdictions and over time, operationalization of study variables, and data access. Several methodological examples will be used to illustrate the challenges and limitations of administrative data.
Patricia L. Mabry, Ph.D.	*A System Dynamics Model of Cardiovascular Disease Risk:*

Office of Behavioral and Social Sciences Research	*Identifying Policy Levers in a Local Context* This talk will describe the development of a system dynamics model of risk factors associated with the first time cardiovascular disease event. This SD model was developed from a national model and adapted to the local context of Austin, Texas. The purpose of the model was to evaluate the policy levers that impact cardiovascular disease risk in the local population. Model development, including selection of boundaries, verification and validation will be discussed along with simulations and the resulting discoveries regarding policy and disease dynamics.
Nathaniel Osgood, Ph.D. University of Saskatchewan	*Exploring the Intra- or inter-generational Impact of Gestational Diabetes on Type 2 Diabetes: Results from the Gestational Diabetes Population Model* We sought to build a population-level dynamic model to investigate the potential impact of gestational diabetes mellitus (GDM) on Saskatchewan's epidemic of Type 2 Diabetes (T2DM) over the past half-century. The model represented birth, aging, weight change, pregnancy, development of GDM and T2DM, immigration, legislated ethnic reclassification, and death. To capture the observed impact on offspring of in-utero exposure to dysglycemia, the model population was stratified by a history of such exposure. Compartments were further stratified by Age (17age categories), Ethnicity (Saskatchewan Registered Indians [RI] and Other Saskatchewan people [OSK]) and (where appropriate) Sex. To capture effects on diabetes risk outside the scope of the model, diabetes rates were sigmoidally trended with an offset. Model parameters were drawn from primary data collected by the authors and collaborators, administrative data, the secondary literature, the Canadian Community Health Survey, and vital statistics. To estimate parameters for which estimates were less readily available, the model was calibrated to a broad set of time series and some data points. The model was cross-validated against an alternative time series not used in parameterization and calibration. Model results suggest that over 30% of diabetes cases amongst RI seen historically in SK may be attributed to the impact of diabetes on either the mother or fetus. Most of this influence of GDM is through the mother, but inter-generational effects are growing, and are likely to become as large as the intra-generational effects in coming decades. Amongst OSK, the effects are much smaller. Gestational diabetes not only appears to be important and highly prevalent in many subpopulations, but is also identifiable, preventable and treatable. In light of many expectant mothers' strong motivations for maintaining healthy habits during pregnancy, an investment in diet and exercise-based preventive measures, improved screening, and treatment could offer substantial benefits in reducing the burden of T2DM in important subpopulations over many generations.

	This is joint work with Roland Dyck and Winfried Grassmann.
Laura Rosella, Ph.D. Post-doc Fellow (Ontario Agency for Healthcare Protection and Promotion) Institute for Clinical Evaluative Sciences	*Using a population-based risk tool to support health planning for diabetes in Canada* Population-based prediction models can be used to inform health policy decisions and to quantify the distribution of diabetes in the population. This talk will review the development and validation of a model that can be applied using commonly-collected national survey data (Diabetes Population Risk Tool or DPoRT) to predict 10-year risk for diabetes in populations. The application of this tool will be demonstrated by presenting future diabetes trends in the Canadian population. In addition, results from modelling intervention scenarios used to quantify potential reductions in future diabetes incidence will be presented.
Regan Mandryk, Ph.D. University of Saskatchewan **&** **Kevin Stanley, Ph.D.** University of Saskatchewan	*Integrating Monitoring into Everyday Activities* In this talk we will examine the current state of the art in smart devices and discuss how these can be used to unobtrusively monitor individuals' activity levels, diet and social situation as part of a medical study or intervention. We will examine the potential of devices such as Zigbee-enabled sensor motes and convergent devices such as the iPhone as innocuous telemetry platforms. Examples of technology from monitoring subjects for weight-loss and for activity levels in an integrated environment will be provided.
Mona Vajihollahi, Ph.D. Candidate Simon Fraser University	*Agent-based models reveal the interplay of physical activity and environment* Physical activity (PA) shows benefits in many aspects of our health and a growing body of research points out the important role of the built environment in shaping people's PA behavior. Our goal is to apply agent-based models to better understand the impact of perceived and objective environmental measures on individuals' decision making regarding PA. Such models would serve as experiment testbeds for identifying how PA is affected by changes to the structure of an environment and to human perception of the environment. They also serve as valuable decision support tools for planners and policy makers by facilitating the analysis of intervention

	policies.
Gary Sacks, Ph.D. Candidate Deakin University	*Modelling cost-effectiveness of obesity prevention interventions in Australia: the Assessing Cost Effectiveness (ACE) approach* As policy makers around the world seek cost-effective solutions to address the obesity epidemic, comparative modelling of different policy options is becoming increasingly important. This talk presents the ACE (Assessing Cost Effectiveness) methodology that was developed in Australia to assist policy makers in determining a prioritised set of interventions. The ACE approach combines epidemiological and economic modelling as well as a due process that involves relevant stakeholders at all stages of the decision making process. The key components of the ACE process are presented, along with the results for Australia, current applications of the process internationally, and future directions.
Y. Claire Wang, M.D., Sc.D. Columbia University, Mailman School of Public Health	*Energy Gap Metrics for Understanding Population Weight Shifts* **Abstract:** Excess weight gain during growth is a result of energy intake exceeding expenditure among children and adolescents. I will overview an energy gap framework as a tool for policy-relevant modeling and simulations. Estimating underlying drivers of population weight shift with this common metric will inform surveillance, goal setting and benchmarking progress. I will also discuss the utility of such common metric for evaluating the comparative effectiveness between interventions.

Obesity prevention in Australia

Modelling cost-effectiveness of interventions: the Assessing Cost Effectiveness (ACE) approach

First Annual Workshop on Dynamic Modelling for Health Policy
Saskatoon, July 2009

Gary Sacks, Marj Moodie, Boyd Swinburn

Deakin University

Presentation outline

– Logic pathway for obesity modelling
– ACE-Obesity in Australia
– Identifying policy interventions
– Energy gap dynamics
– Future directions

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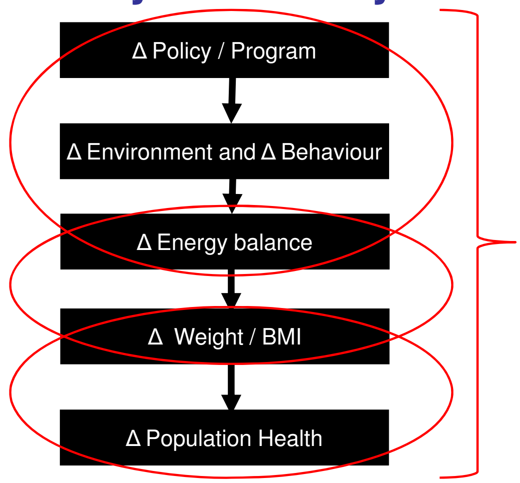
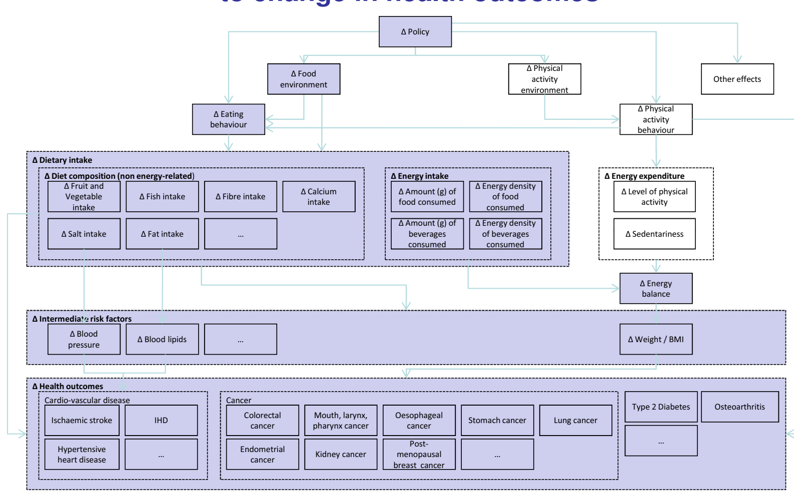
Logic pathway for obesity modelling



Logic pathway: Change in food and physical activity policy to change in health outcomes



Reference: Sacks, Snowdon and Swinburn (in preparation)

Presentation outline

- – Logic pathway for obesity modelling
- – ACE-Obesity in Australia
- – Identifying policy interventions
- – Energy gap dynamics
- – Future directions

Background

- Investment in obesity prevention increasing
- Funding decisions often not underpinned by evidence – limited information on what works and offers value-for-money
- How do you set priorities for obesity prevention?

⬇

ACE-Obesity Project
(Assessing Cost Effectiveness in Obesity)

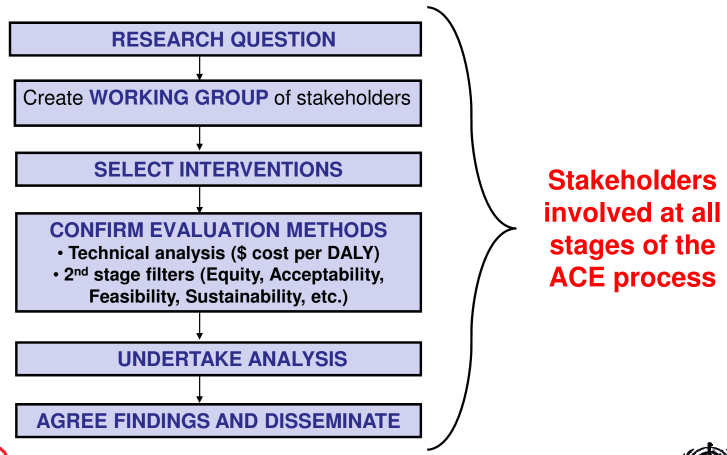
Project overview

- Two year project in Victoria, Australia
- Evidence-based approach to evaluate the cost-effectiveness of interventions for the prevention of unhealthy weight gain in Australian children and adolescents
- Used a standardized methodology to evaluate and prioritize multiple interventions

Key features of ACE approach

- Clear rationale and process for selection of interventions
- Evidence-based
- Information assembled by an independent research team
- Measurement of benefit based on technical cost-effectiveness results and qualitative analysis with stakeholders

Overview of ACE approach



ACE-Obesity – Selected interventions

Child care

1. Active After-School Communities

Schools

2. Multi-faceted school-based program (- PE)
3. Multi-faceted school-based program (+ PE)
4. Targeted school-based program
5. Education program to reduce fizzy drinks
6. Education program to reduce TV viewing

Primary care

7. Family-based GP program for overweight
8. Family-based targeted program for obese
9. Orlistat therapy for adolescents

Hospital

10. Gastric banding for morbidly obese

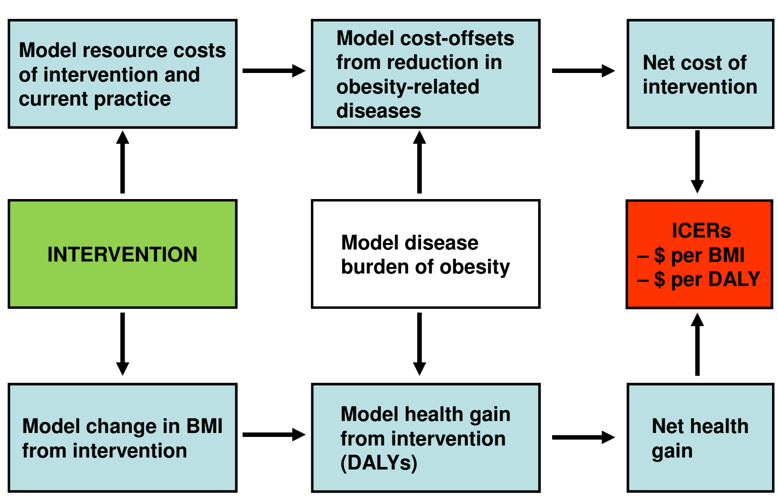
Neighbourhoods & communities

11. TravelSMART Schools
12. Walking School Bus

Media and marketing

13. Reduce TV advertising of junk food

Overview of ACE-Obesity technical analysis



Study parameters – technical analysis

- Standardised evaluation methods
- A common setting, target group, reference year, perspective, decision context
- Measured against current practice
- Australian data used to calibrate the model
- Costs and benefits tracked for cohort to100 years of age or death
- Extensive use of probabilistic uncertainty analysis and sensitivity analysis

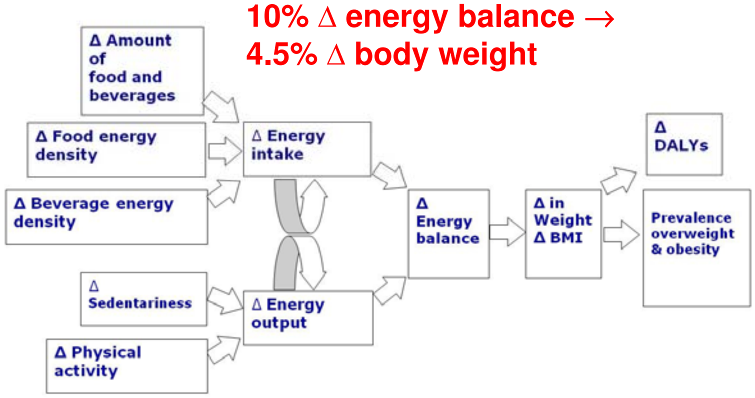
Economic modelling

- Measuring net costs of intervention
- Pathway analysis – identify all steps in intervention to determine associated resource use
- Costed in steady state – running to full effectiveness potential, no workforce issues, excludes planning and set-up stages
- Time horizon of intervention – reflect real-life application
- Cost-offsets – savings as a result of reduction in obesity related diseases

Deakin University WHO Collaborating Centre for Obesity Prevention

Assessment of benefit

10% Δ energy balance → 4.5% Δ body weight



Reference: Swinburn et al AJCN 2006

Estimate reduction in BMI for a single 'average' child who participates in AASC program

Boys 5-9 yrs

Body Mass Index, BMI	16.83	Mean BMI for specific age groups
Estim. total energy expenditure (MJ/day)	6.94	Total energy expenditure (Mj/day) = [.107 x weight (kg)] + [2.91 x height (metres)] + .417
Estim. total energy expenditure (kJ/day)	6,943	Convert to kilojoules :x 1000
Increased METS – playing sport (versus sitting)	4.0	Playing of sport METs of betw. 2.5 and 9.0. Used MET = 5.0 (equates to additional energy exp. of 4.0 cf. to 1 for quiet sitting
Extra time spent on p.a. (mins)	60.0	Min. 1 hour in AASC funding guidelines
Energy expenditure increase from AASC participation (kJ/day)	449	= weight (kg) x increased METs x time (hrs) x factor for converting kcal to kJ (4.2)
Aver. no. days of participation per wk	2	
Total days per year	64	2 days/wk x 8 weeks/term x 4 terms
Energy expenditure increase (kJ/day)	79	Total increase in individual energy expenditure x no. days per year divided by 365. (449 x 64 / 365)
Relative increase in energy expenditure	1.13	Average individual energy expend. as % estim. total energy expend. per day
Conversion factor	0.447	Factor to convert relative change in energy balance to relative change in body weight
Relative lower weight with intervention	0.51	$[1-(\text{energy expenditure}_1/\text{energy expenditure}_2)^{0.45}]*100$
Absolute lower weight with intervention	0.14	% original weight
New weight (kg)	26.59	Original mean weight minus decrease in weight
New BMI	16.75	New weight divided by square of height
Reduction in BMI	0.085	Original mean BMI minus new BMI

BMI to DALY modelling (1)

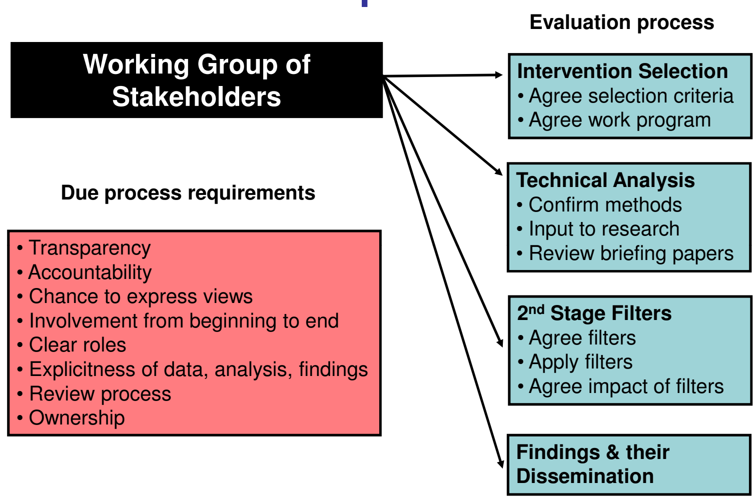
- Start with BMI distribution (mean, SD) by 5 yr age and gender
- Outcome: DALYs saved due to intervention = difference in future mortality and morbidity outcomes between baseline (current practice) and intervention
- These differences based on changes in age-specific BMI distribution of target population over their remaining life
- Use historical BMI data to develop regression equation – then move cohort through life in 5 yr cycles

BMI to DALY modelling (2)

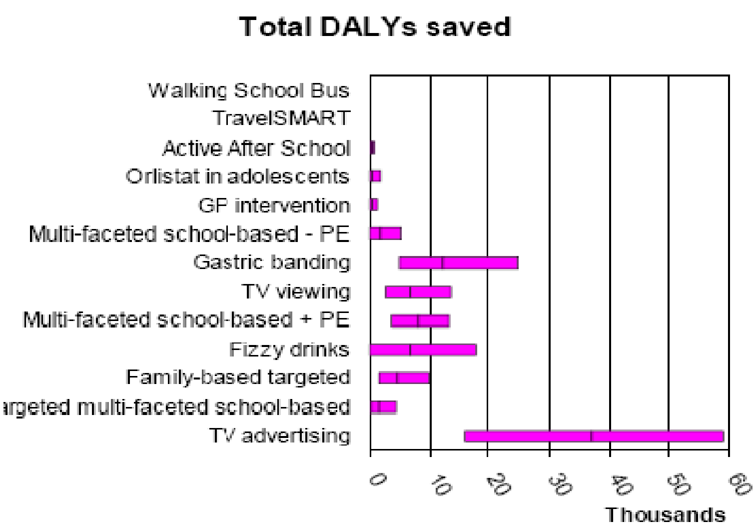
– Calculate Potential Impact Fractions (PIFs) – proportional change in expected disease or death attributable to change in exposure to risk factor

– The diseases for which PIFs were calculated are:
  - Ischaemic heart disease
  - Ischaemic stroke
  - Hypertensive heart disease
  - Type 2 diabetes
  - Osteoarthritis
  - Cancers (endometrial, colon, kidney, post-menopausal breast)

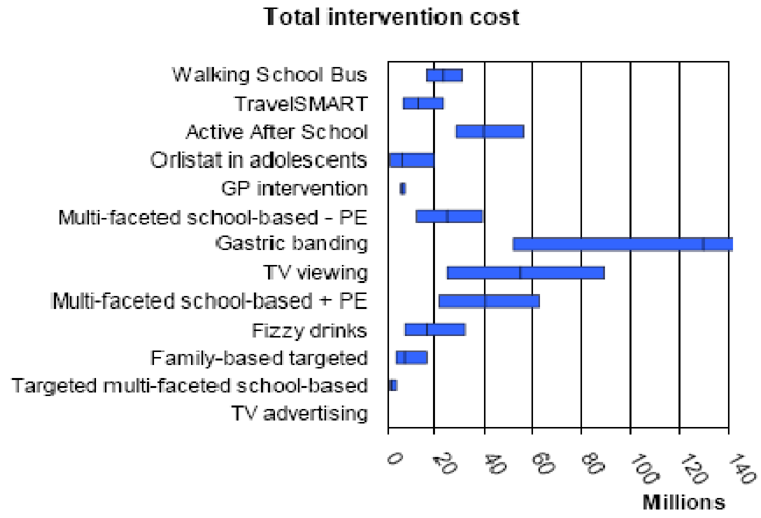
Overview of 'due process'



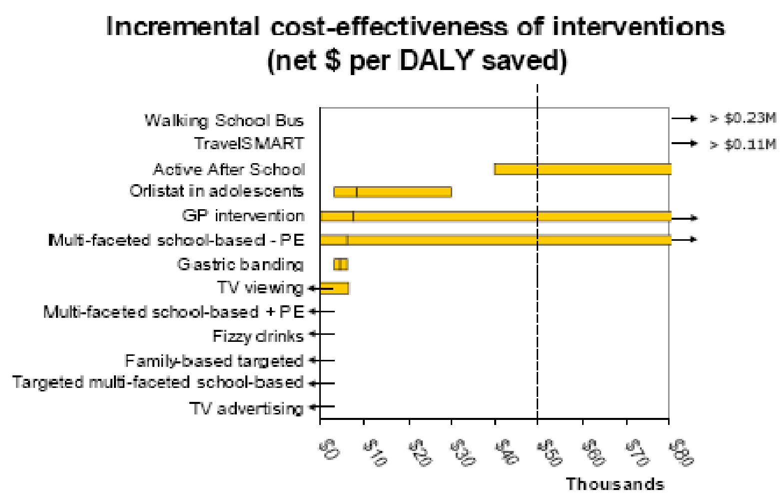
Results: Effectiveness



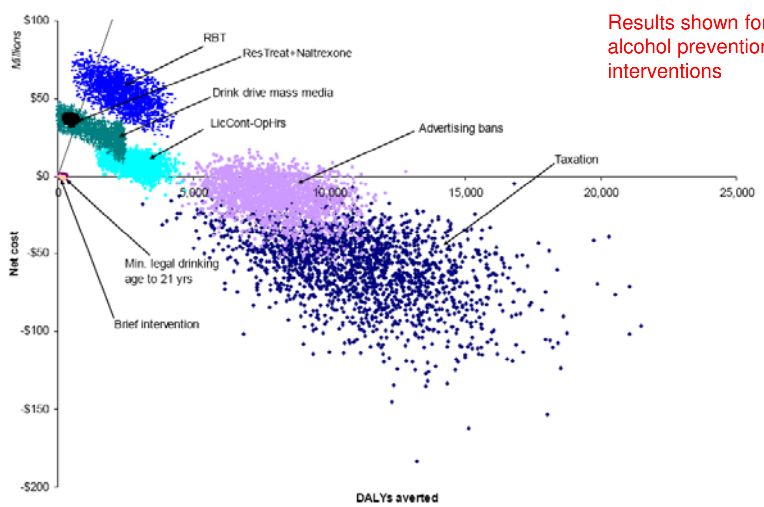
Results: Affordability



Results: Cost-effectiveness



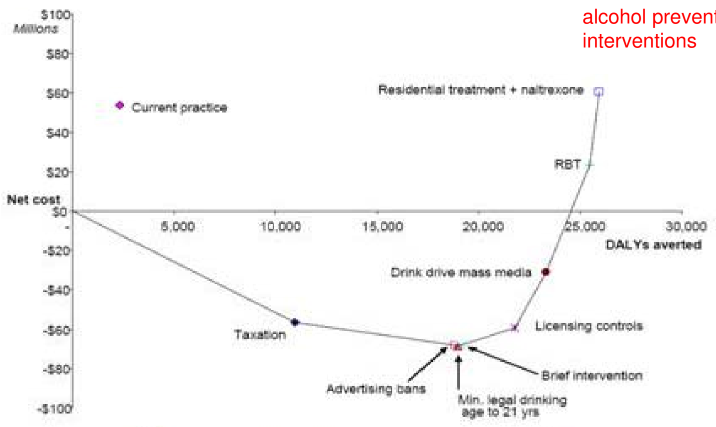
Results: Cost-effectiveness plane



Results shown for alcohol prevention interventions

Results: Intervention pathway

Results shown for alcohol prevention interventions



2nd stage filter analysis – issues

- Contrary to known government policy **(regulation of TV advertising)**
- Potential for side-effects **(gastric banding, Orlistat)**
- Acceptability **(gastric banding, Orlistat)**
- Affordability **(gastric banding)**
- Sustainability **(Walking School Bus, Active After-School Communities program)**
- Important implications for other areas of government eg. Dept of Education **(school-based interventions)**
- Strength of evidence **(GP intervention)**

Conclusions and implications

– Policy interventions often inexpensive
– Energy intake interventions more potent than physical activity – but both are needed
– Reach is a big determinant of total costs and health benefits
– Packaging interventions complicated by broad factors (qualitative considerations, joint costs, cumulative impact of multiple interventions, targeted vs non-targeted interventions)
– Need multiple strategies in multiple settings with multiple partners
– Better evaluations of interventions required
– ACE process provides useful information for policy-makers, despite limitations

Presentation outline

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- ACE-Obesity in Australia
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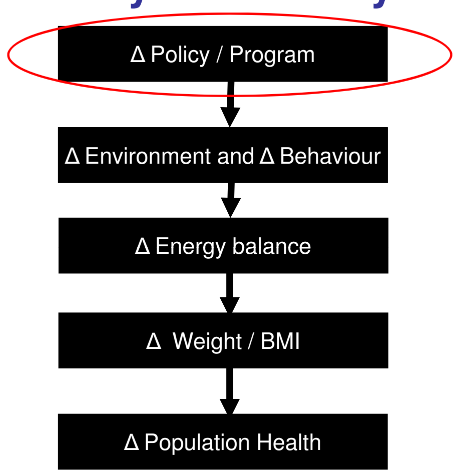
- Future directions

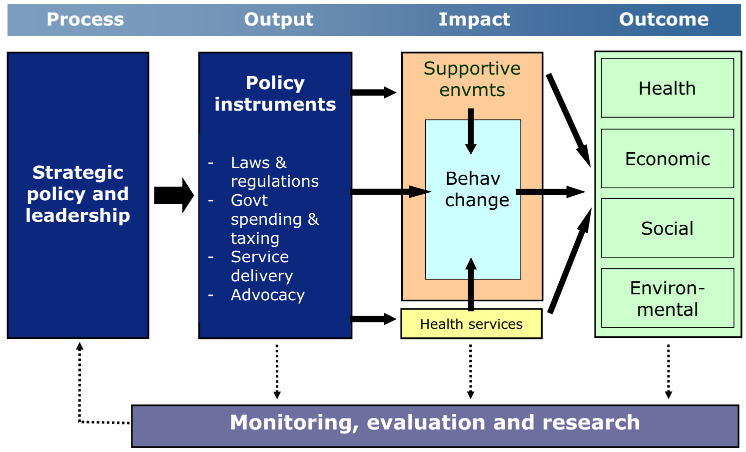
Logic pathway for obesity modelling



Obesity law and regulation project

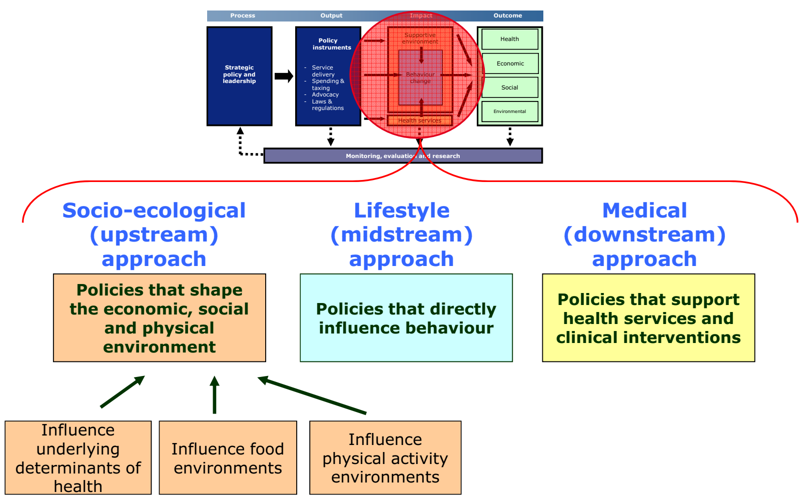
- 5 year National Health and Medical Research Council (NHMRC) project grant
- Joint Deakin University and Monash University (public health lawyers)
- Identifying promising legal interventions (interviews with government t stakeholders at all levels)
- Ultimately will model 'best buys'

Obesity prevention policy framework



Sacks et al *Obesity Reviews* 2009 (Adapted from WHO Global Strategy for Diet & Physical Activity Framework)

Integrating different public health approaches



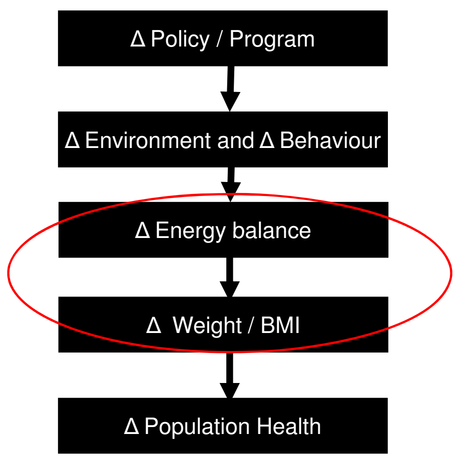
Policy areas that influence food environments

SECTOR	LEVEL OF GOVERNANCE: LOCAL GOVERNMENT	STATE GOVERNMENT	NATIONAL GOVERNMENT	INTERNATIONAL	ORGANISATION
PRIMARY PRODUCTION	• Land-use management (zoning) • Community gardens	• Agricultural subsidies	• Taxes on primary production • Agricultural subsidies • Research and development in agriculture	• Wealthy countries (e.g. USA, EU) agriculture subsidies	
FOOD PROCESSING		• Food safety	• Food composition standards • Food composition monitoring		
DISTRIBUTION	• Farmers markets	• Food transport • Access of fresh foods in remote areas	• Import tariffs • Import restrictions / restrictions on supply	• Trade arrangements between countries	
MARKETING	• Marketing to children (billboards and signage)	• Marketing to children • practices in schools	• Marketing to children • Consumer protection	• Marketing to children	• Marketing to children
RETAIL	• Land-use management (zoning)	• Products sold in schools	• Nutrition labelling • products		• Product placement in stores
CATERING / FOOD SERVICE	• Community kitchens • Number of fast food outlets	• Nutrition information in restaurants			• School food policies • Standards for food served in • Food procurement policies

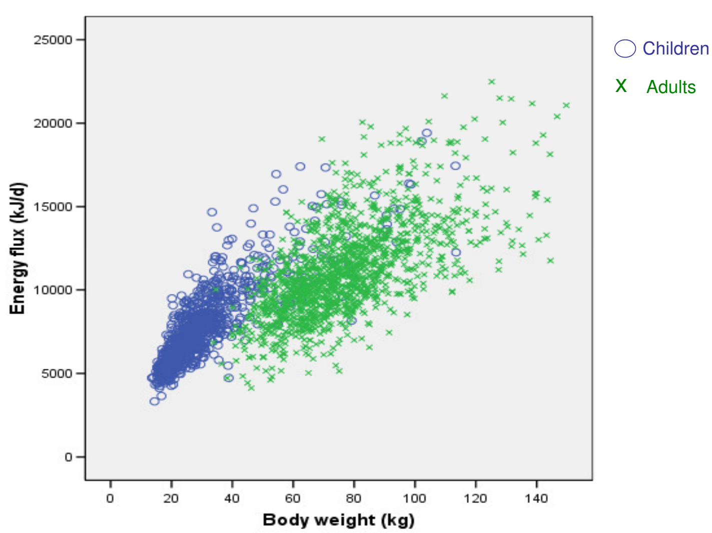
Presentation outline

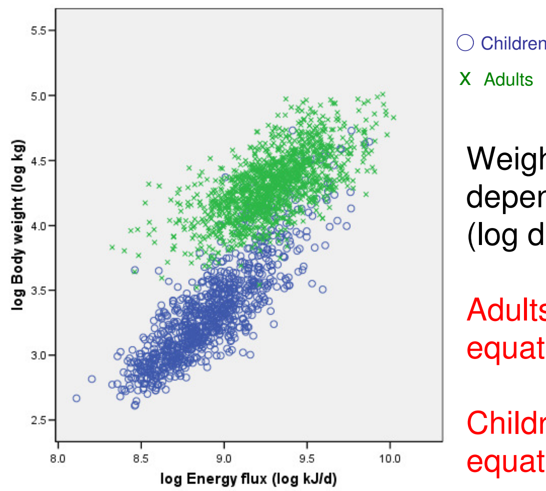
- – Logic pathway for obesity modelling
- – ACE-Obesity in Australia
- – Identifying policy interventions
- – Energy gap dynamics
- – Future directions

Logic pathway for obesity modelling



Relationship between energy & weight



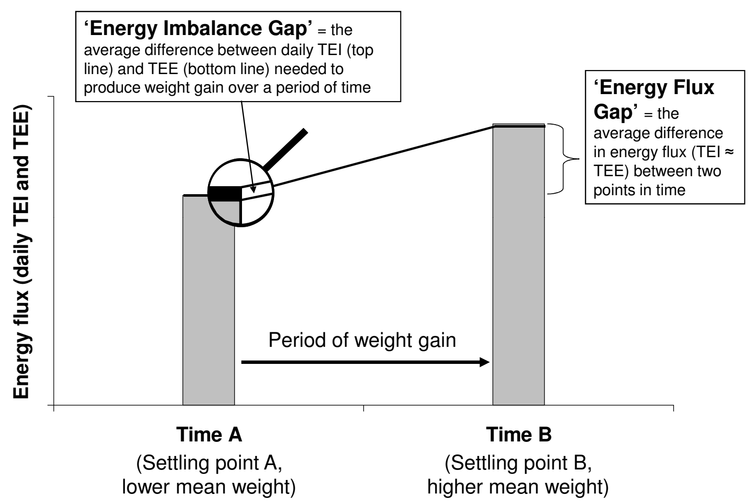


Weight as the dependent variable (log data)

Adults: β = 0.71 (full equation r^2=0.52)

Children: β = 0.45 (full equation r^2=0.86)

Energy gap concepts



Presentation outline

– Logic pathway for obesity modelling

– ACE-Obesity in Australia

– Identifying policy interventions

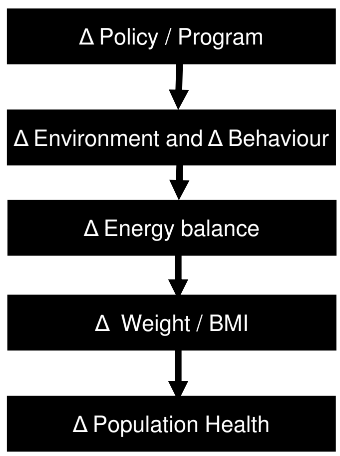
– Energy gap dynamics

– Future directions

Other ACE-related work

- ACE Prevention project – 100 preventive, 50 treatment options across a range of chronic diseases
- Internationalization of ACE-Obesity (USA, Malaysia, New Zealand)
- Another round of ACE linking obesity and climate change – Raises methodological issues around measuring and health and environmental outcomes in a way meaningful to policymakers

Logic pathway for obesity modelling



Acknowledgements

- Boyd Swinburn
- Rob Carter
- Marj Moodie

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References (ACE process)

- Carter R et al. *Expert Review of Pharmacoeconomics and Outcomes Research.* 2008;8(6):593-617.
- Haby MM et al. *Int. J Obesity* 2006; 30; 1463-75.
- Moodie M et al. *Economics and Human Biology* 2008; 6:363-76.

Thank you!

NAVAL POSTGRADUATE SCHOOL

THINKING IN CIRCLES ABOUT OBESITY

By
Tarek K. Abdel-Hamid

First Annual Workshop on
Dynamic Modeling for Health Policy
University of Saskatchewan
July 22-24th, 2009

- DM Problem
- Energy Bal. Equ: Reigning Intellectual Paradigm or Straitjacket
- Leverage Points to Intervene in Systems
- Personal Health Decision Support tools
- Not Automating… Obliterating

"How Does a Nice Guy Like You Get Involved in *this* **?"**

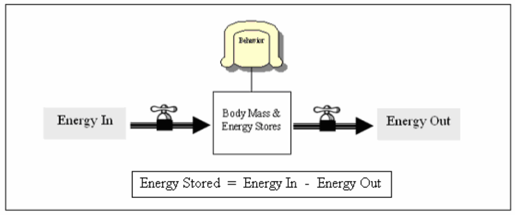
- In managing our health—and our bodies—we are *decision makers* who are managing a truly complex and dynamic system
- Recent advances in medicine have made the task of personal health management *more*, not less, complex.
- Most obese individuals attempting to lose weight do so *themselves*, without seeking professional.
- Heretofore, public policy driven by the belief: "if you educate...them, they will change" ... It's *not* working
- Knowledge *restructuring*… not knowledge *accretion*
- Understanding *not* enough

  We'll PhDs to the masses

It is *NOT* just Automating… It's *Obliterating*

- Expanding repertoire of IT enabling enormous opportunities for empowering people with tools for personal health management.
- To-date, however, most applications are electronic reincarnations of "legacy" tools from the pre-Internet era.
- It is time to stop paving the cow paths! Instead of embedding outdated models in silicon and software, we should obliterate them and start over.

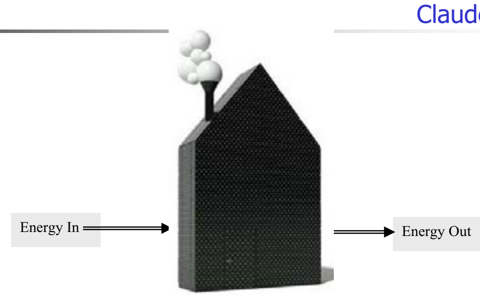
The Energy Balance Equation: Reigning Intellectual Paradigm or Straitjacket?



- It is a linear model. Also static, unbounded—and just plain wrong
- Legacy of earlier times when we were computationally poor
- We rely on models to: (1) Understand; (2) Predict

"Like trying to tell what happens inside a house by watching what goes in by the door and what comes out of the chimney."

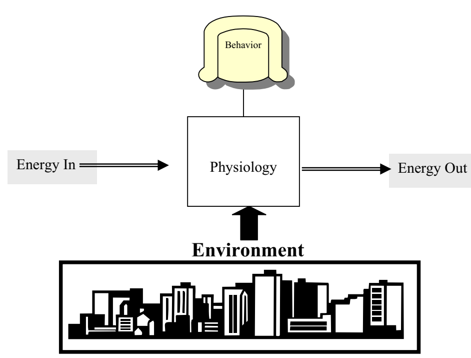
Claude Bernard



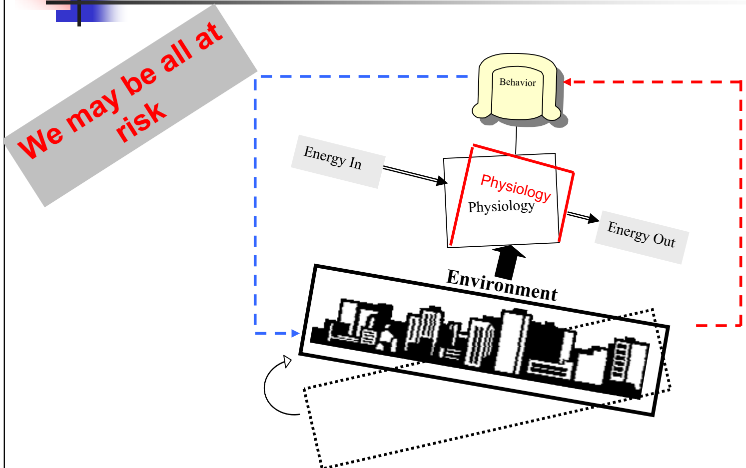
- People instinctively believe that the body's regulatory system strives to maintain stability at some "natural" body weight, defending against both weight loss and weight gain.

Historically energy regulation was simple: Environment shaped our physiology, which, in turn, regulated our behavior

No Worries

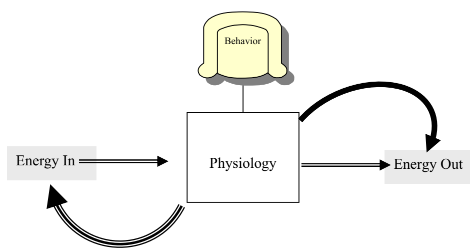


We changed our Environment... and now our environment is changing us



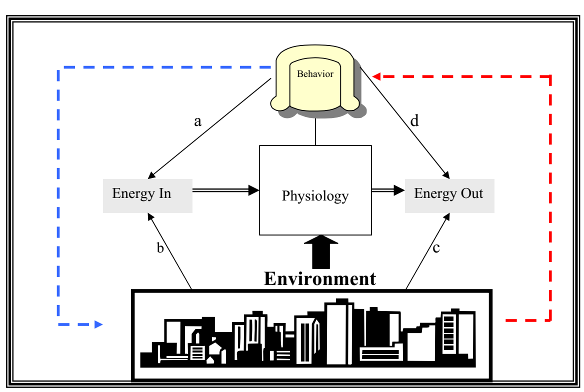
There is a *lot* more under the "surface"

- Human bioenergetics belongs to the class of multi-loop nonlinear feedback systems



Our bodies work in circles, people think in straight lines

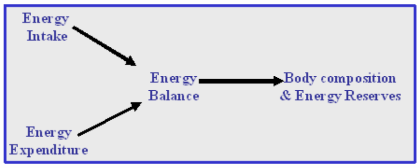
Location, Location, Location: Leverage Points/Places to Intervene in Systems



Metanoia

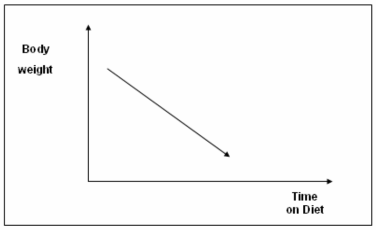
- An irony of America's obesity epidemic is that, at a time when Americans arguably know more about food and nutrition than at any time in their history, they are gaining more weight
- Effective self-regulation of health behavior, like in any other endeavor, requires certain cognitive skills
- It may be time for a "metanoic" jump in addressing the obesity epidemic.

Understanding is Enough with *Simple* Systems

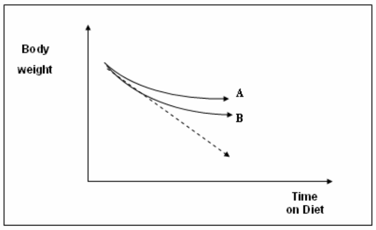


Understanding is *not* Enough

Linear Model… One scenario



Feedback Model… Multiple scenarios



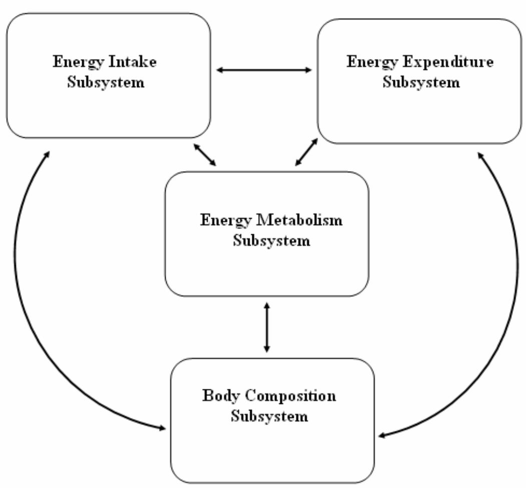
- Discerning dynamic behavior of individual loops in isolation can be reasonably obvious, but figuring out the behavior of multi-loop system tricky.
- Human information processing, as marvelous as it is, falters when it comes to dynamic behavior of multi-loop nonlinear systems

PHDs for the Masses…
That's Personal Health Decision support

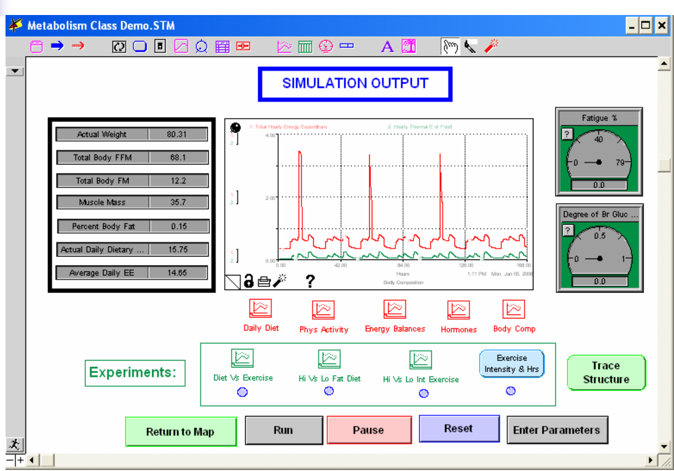
New generation of Dynamic tools:

- More accurate
- More Personal
- More Discriminate

Model's four Sub-Systems



Model Interface



Experiment 1:
Going Ballistic—on a Diet

Accuracy matters. Repeated failures to attain expected weight-loss targets often leads to loss of *self-efficacy*.

Experiment 1:
Going Ballistic—on a Diet

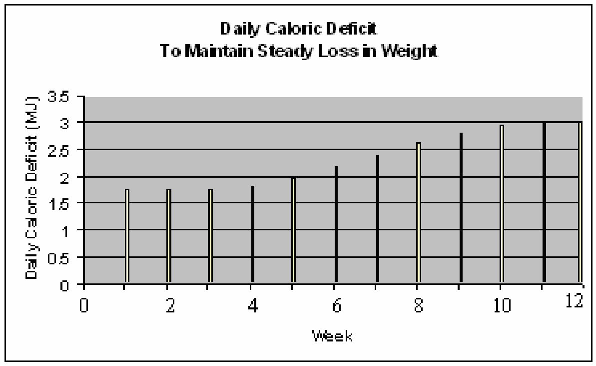
Accuracy matters. Repeated failures to attain expected weight-loss targets often leads to loss of *self-efficacy*.

People manage their bodies ballistically: setting a weight-loss target, calculating a diet's caloric deficit, and launching.

Managing our bodies is akin to pursuing a target that not only moves but also reacts to the actions of the pursuer.

Experimental Subject

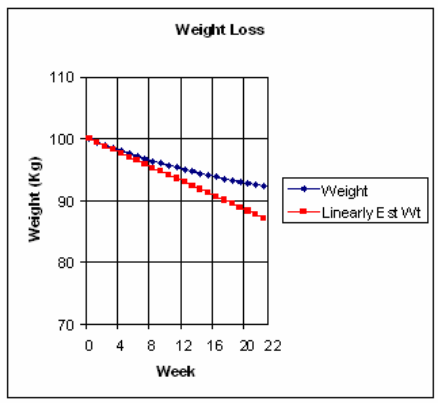
- A hypothetical overweight sedentary male
- Initial total weight of 220 pounds (100 kg) and 25 percent body fat.
  - At six feet (1.83 meters) tall, his body mass index (BMI) is 30
- SS average daily dietary input: 3,400 kcal.

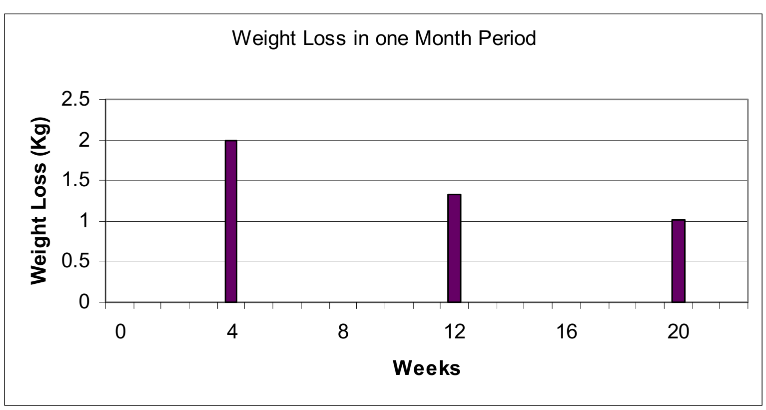


- To sustain a constant rate of weight loss—most people's expectation when starting a diet—the caloric deficit must progressively increase over time. Not by a little, but by a significant amount.
- By the 12th week, the daily caloric deficit almost *doubles*

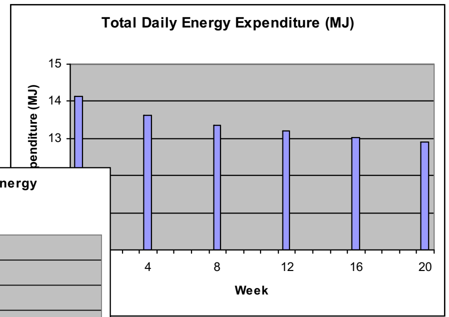
Reality versus Fiction in Assessing Weight Loss

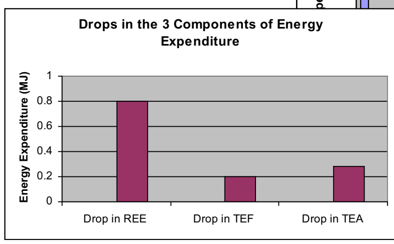
- Accuracy matters
- The simplistic linear estimate over-estimates weight loss by 4.8 kg— 63 % more than the actual 7.75 kg loss over the 22-week period.
- Using a simplistic energy balance equation may help sell more diet books, but it will inevitably lead to spurious predictions of treatment outcomes.





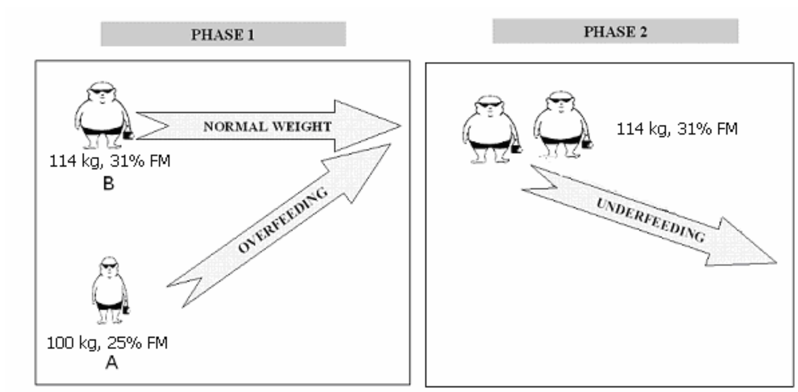
Looking Inside the White Box

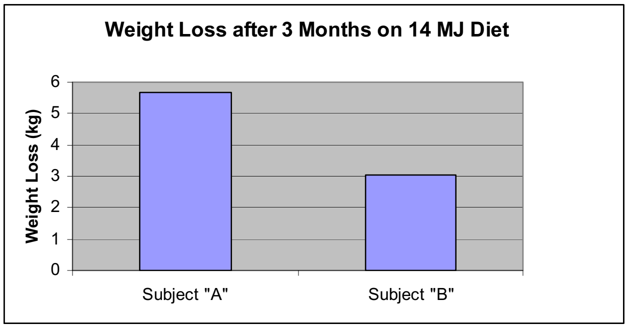




Experiment 2:
Why 250 lbs ≠ 250 lbs

- Obese patients are not a single homogenous group—however similar they may look
- Individual Differences—more than Meets the Eye
- *Dynamic* dimensions, as well *static*
- Dynamic aspects—such as the time history of weight gain—imply that, *for the same individual*, response to treatment can change over time.

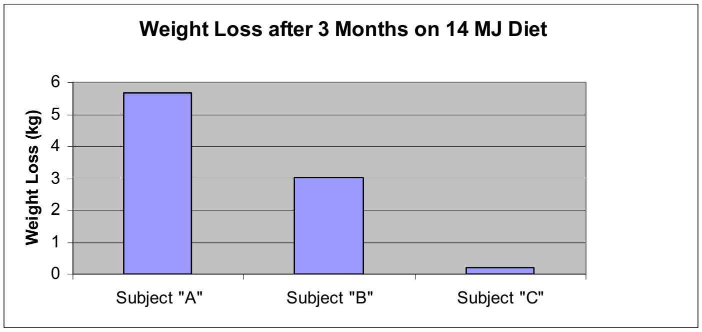




• After 3 months on same diet: “A” loses 5.68 kg, “B” loses only 3.04 kg

•“A’s” elevated REE level (as a result of his recent overfeeding behavior) pushes his REE rate (at 10.73 MJ/day) ten-percent higher than “B’s” (at 9.71 MJ/day)

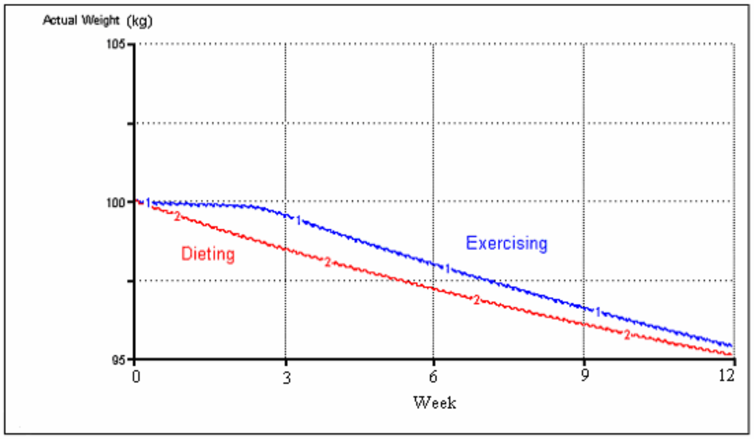
114 kg ≠ 114 kg ≠ 114 kg!

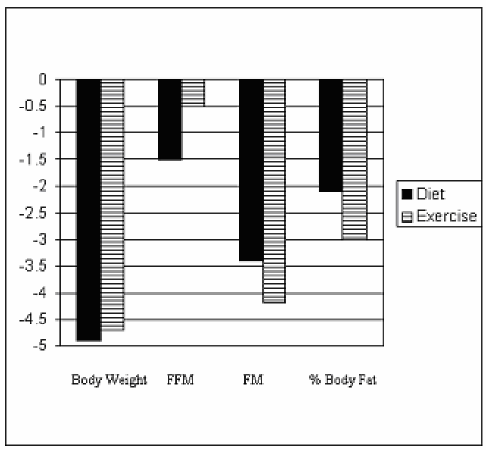


Mr. “C.” has been chronically overweight at 114 kg. But, unlike both “A” and “B,” who have similar body composition, C’s percent FM is higher at 40 %.

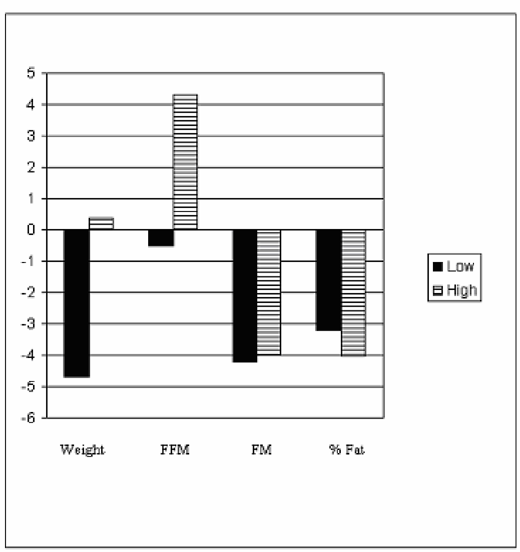
Experiment 3: Trading Treatment Options... Diet versus Exercise

- Energy is not a Single Currency
- How an energy deficit is created matters

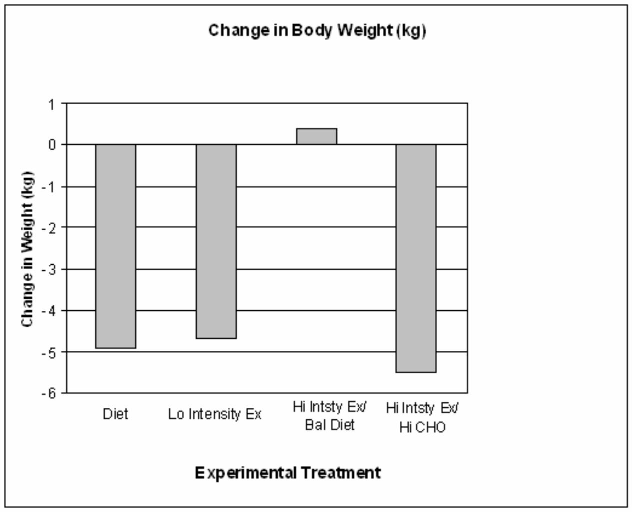


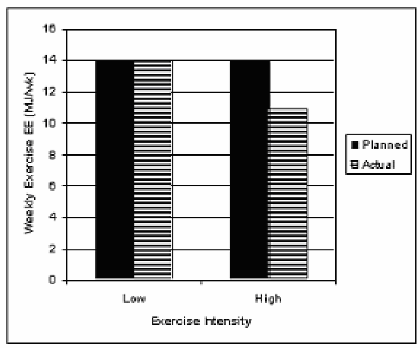


Diet vs. Exercise



Low vs. High Exercise Intensity

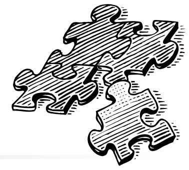




Actual vs Planned Weekly Exercise Energy Expenditures At Low and High Exercise Intensity Levels

The Second Flowering

- Historians have called the late 19th century the time of the "great flowering of medicine."
- Today, we may be on the verge of a second flowering—one in which medicine seeks not just to overcome disease, but to develop our capacities so that our human potential finds its optimal expression.



All the Pieces are in Place

- (1) Advances in molecular biology... expanding our understanding of the fundamental processes that underlie how the body works
- (2) Advances in systems and computational sciences... allowing us to mathematically model and predict these processes
- (3) Ubiquitous computing systems and intelligent sensors that can sense, analyze and communicate the physiologic data needed to personalize these models.
- (4) Internet... provides the infrastructure to efficiently and economically deliver these capabilities to large numbers of people.

Not Automating… Obliterating

- To-date, however, most applications are electronic reincarnations of "legacy" tools from the pre-Internet era.
- A personal health simulator would allow each of us to have, in essence, an imaginary "virtual twin" with which to predict the state of our health under different lifestyle scenarios and/or health interventions.
- "Intimate" tool would help us understand how *we* might develop a health problem and which behavior or personal attributes we might change to prevent it.
- Furthermore, the specificity of individualized tools would go a long way toward breaking down our defensive biases—such as that pervasive illusion of unique invulnerability

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- Book:
  - Hamid, T.K.A. *Thinking in Circles about Obesity: Applying Systems Thinking to Weight Management*, Springer, August, 2009.
- Journal Articles
  - Abdel-Hamid, T.K. Exercise and Diet in Obesity Treatment: An Integrative System Dynamics Perspective. *Medicine & Science in Sports & Exercise,* Vol. 35, No. 3, March, 2003: 400-413.
  - Abdel-Hamid, T.K. Modeling the Dynamics of Human Obesity. *System Dynamics Review*, Vol. 18, No. 4, Winter, 2002: 431-471.

Using a population-based risk tool to support health planning for diabetes in Canada

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Ontario Agency for Health Protection and Promotion (OAHPP)

Dalla Lana School of Public Health ,University of Toronto

MANITOBA CENTRE FOR HEALTH POLICY

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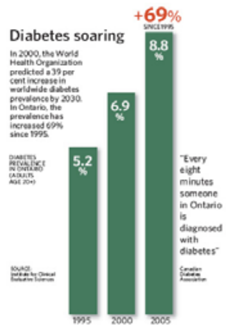
- DLSPH, U of T: Paul Corey, Cam Mustard
- PHIAT-DM Study Team
- CIHR & PHAC

Learning Objectives

1. To introduce a population based risk algorithm for physician diagnosed diabetes
2. To demonstrate the use of risk algorithms for chronic disease planning at the population level
3. To discuss specific issues related to measurement

Diabetes

- Prevalence of obesity has doubled in Canada from 1985 – 1998 and continues to rise
- WHO: "Diabetes deaths will increase > 50% in the next 10 years without urgent action"



Katzmarzyk PT. CMAJ 2002, Lipscombe LL, Hux JE. Lancet 2007

Why prediction?

- Studies that predict or forecast what will happen in the future have contributed to our understanding of the world and the value of strategies modify the likely course of events in many other settings
- Engineering, Economics, Environment
- Estimate the impact of policy changes such as tax hikes or tax changes
- Impact of average global temperature rise or rise on sea levels
- Education, justice, and medicine

IN OTHER POLICY MAKING SETTINGS

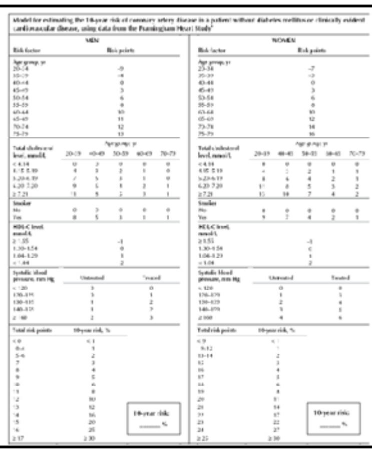
- Policy evaluation tool for resource management
  - Tools capable of evaluating policies on a large scale system to allow policy makers to evaluate several alternatives before deploying them
- Labour laws and tax programs
- To identify groups to target for government programs
- Changes in the environment

What is a risk algorithm?

- This method uses an approach that is widely used in the clinical setting - risk algorithm - and applies this to the population setting
- A risk algorithm:
  - Predicts risk of an outcome – usually a disease state
  - Risk is expressed as a probability
  - Calculated for individuals, but can be summarized for groups
  - Typically used when there is multiple factors that contribute to risk
  - Primarily used as a **decision making tool**

IN MEDICINE…

Algorithm	Primary Endpoint	Use
*Framingham	-Coronary Heart Disease	-Individual pharmacologic, lifestyle, or surgical interventions
FINNRISK	-Incident Diabetes	-Individual pharmacologic or lifestyle interventions
Reynolds Risk Score	-Heart and Stroke Risk	-Decisions about hospitalizations for patients with pneumonia
Gail risk score	-Breast Cancer	-Used in research studies
Fine	-Death in Pneumonia patients	-Decisions about hospitalizations for patients with pneumonia



Risk algorithms in populations

- In the clinical setting, predictive studies have contributed to tremendous advances in individual patient treatment

At the population level:

- Forecast future incidence of disease
- Casts future needs for medical resources
- Stratify the population by risk
- Adjust for baseline risk in research studies
- Estimate the impact of population based interventions

BMJ **Effectiveness and efficiency of different guidelines on statin treatment for preventing deaths from coronary heart disease: modelling study**

Douglas G Manuel, Kelvin Kwong, Peter Tanuseputro, Jenny Lim, Cameron A Mustard, Geoffrey M Anderson, Sten Ardal, David A Alter and Andreas Laupacis

BMJ 2006;332;1419-; originally published online 31 May 2006; doi:10.1136/bmj.38849.487546.DE

•Using this approach, Manuel et al. showed that small changes to the Canadian lipid guidelines should lead to thousands of additional CVD deaths avoided while at the same time saving 100s of millions of health care dollars

Diabetes Population Risk Tool (DPoRT)

OBJECTIVE: To develop a population based risk tool for Diabetes Mellitus (DM) that is valid, reliable and accessible for all levels of health

- Validity in this context:
  1. With the available factors is this the best model that can be found (statistical)
  2. Does the model predict accurately for its intended purpose (policy relevant)

DIABETES POPULATION RISK TOOL (DPORT)

- Meaningful
- Policy relevant
- Simple
- Practical
- Validated (in 2 external population cohorts)

Vision

- Enable a health planner to take the characteristics from their population and estimate the number of new diabetes cases in their population for the purpose of:
  - Resource planning
  - Prevention
  - Understand distribution of risk in the population
  - To facilitate decision making and priority setting

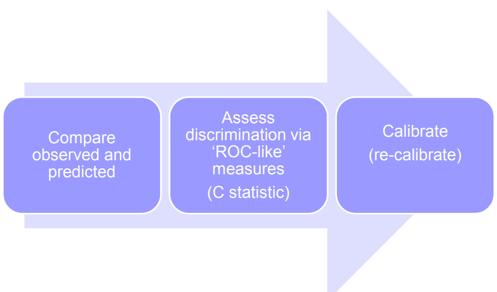
Key challenge

Balancing accessibility with model performance

Data sources:

- **DEVELOPMENT COHORT:** Linked1996/7 NPHS in ON (N=23,403)
- **VALIDATION COHORT 1:** Linked 2000/1 CCHS in ON (N=37,463)
- **VALIDATION COHORT 2:** Linked1996/7 NPHS in MB (N=10,118)
- Risk attributes: only those that are routinely and publicly available (in the NPHS and CCHS)
- Outcome - physician-diagnosed diabetes (ODD & MB version)

Validation Process



Calibration and Discrimination

George Diamond

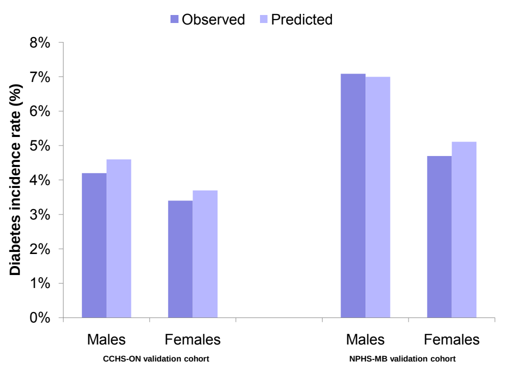
- A prediction model cannot be both perfectly reliable and discriminating …
- Maximizing discrimination is done at the expense of reliability and vice versa

"At best they can be made to form a very unstable emulsion – akin to a Béarnaise"

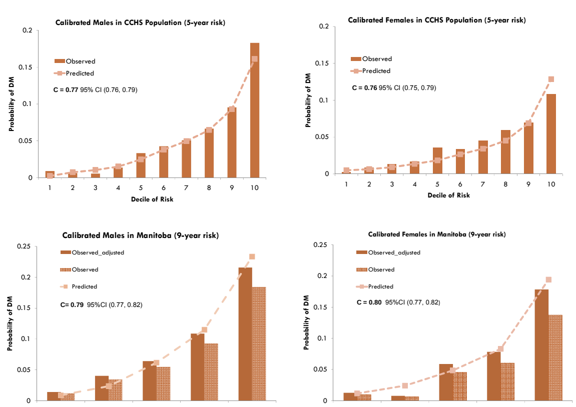
- Balanced with additional variable constraints

Attributes of DPoRT

MALES	FEMALES
Body Mass Index (Kg/m2)	Body Mass Index (Kg/m2)
Age	Age
Non-white Ethnicity	Non-white Ethnicity
Prevalent hypertension	Prevalent hypertension
Smoking	Immigrant Status
Prevalent heart Disease	Post Secondary Education
Post Secondary Education	



Observed and Predicted by Risk Categories in Two External Cohorts

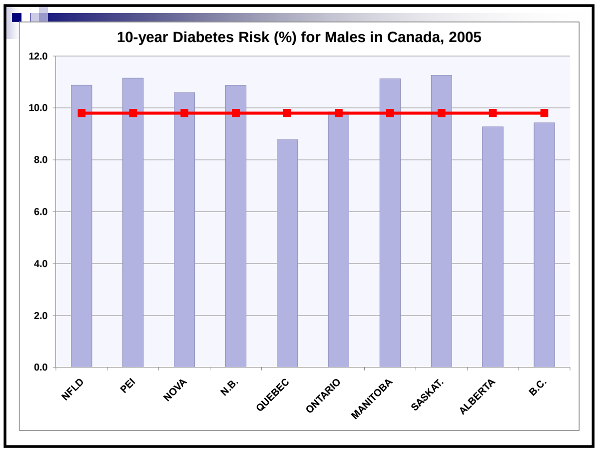


Applying the risk tool

Predictions using public Canadian data:
By Geography
By Risk Groups
By Time

METHODS: ESTIMATING DIABETES RISK

- Sex-specific DPoRT models can be applied to any of the national health surveys in Canada (NPHS or CCHS) for those who are 20 year + and free of diabetes at baseline
- The number of new cases is estimated by multiplying the diabetes risk (probability) by the population number
- To examine age-specific risks were applied to a standard population


10-year Diabetes Risk (%) for Males in Canada, 2005
12.0
10.0
8.0
6.0
4.0
2.0
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NFLD
PEI
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QUEBEC
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SASKAT.
ALBERTA
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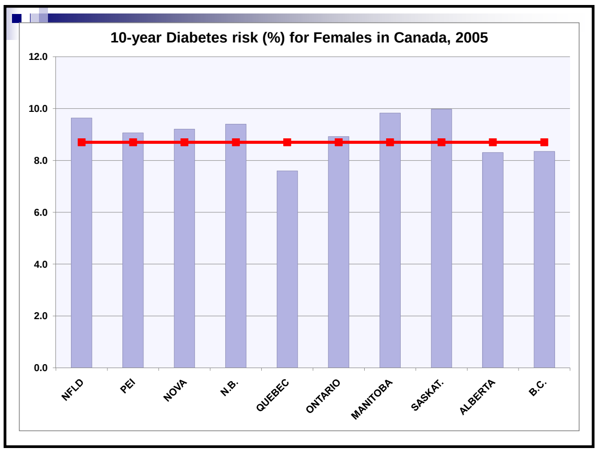
10-year Diabetes risk (%) for Females in Canada, 2005
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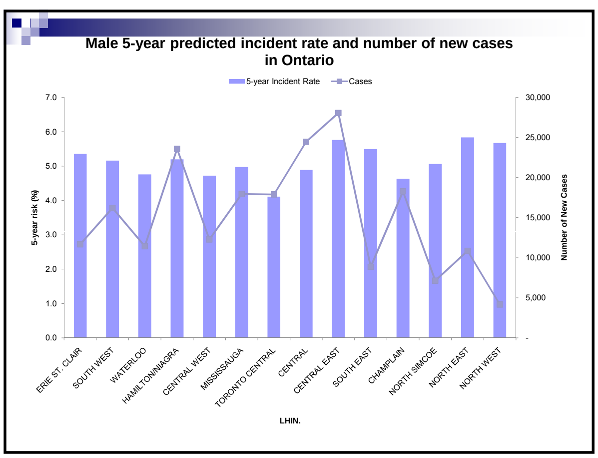
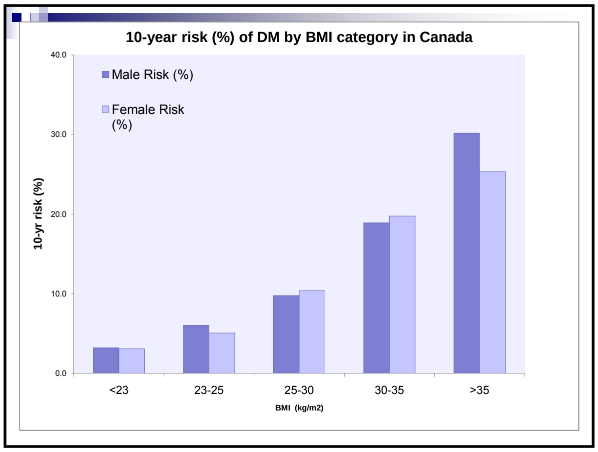
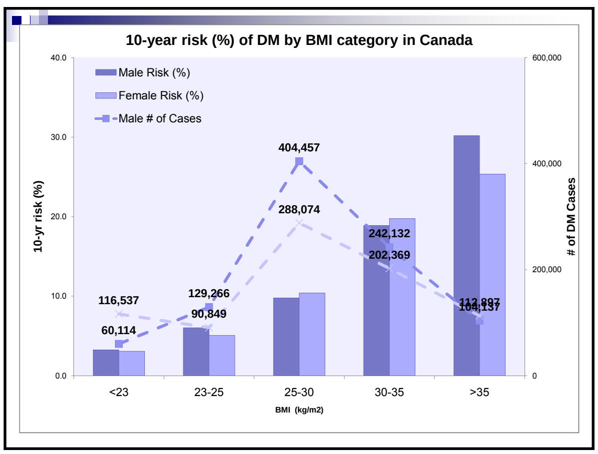
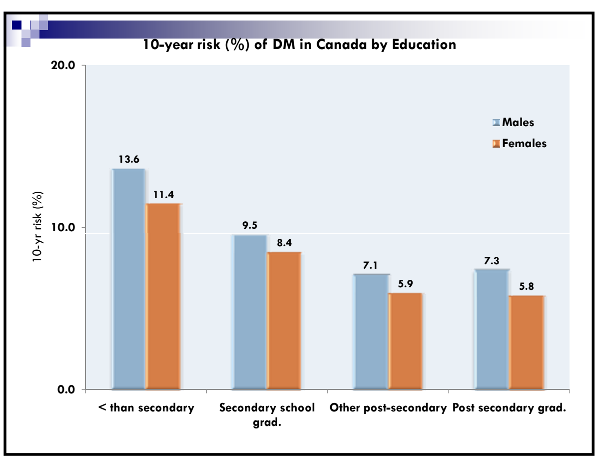

Male 5-year predicted incident rate and number of new cases in Ontario
5-year Incident Rate
Cases
5-year risk (%)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Number of New Cases
30,000
25,000
20,000
15,000
10,000
5,000
-
ERIE ST. CLAIR
SOUTH WEST
WATERLOO
HAMILTON/NIAGRA
CENTRAL WEST
MISSISSAUGA
TORONTO CENTRAL
CENTRAL
CENTRAL EAST
SOUTH EAST
CHAMPLAIN
NORTH SIMCOE
NORTH EAST
NORTH WEST
LHIN.

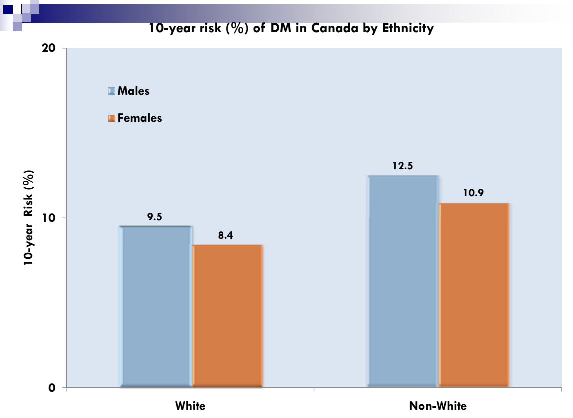

10-year risk (%) of DM by BMI category in Canada
Male Risk (%)
Female Risk (%)
10-yr risk (%)
40.0
30.0
20.0
10.0
0.0
<23
23-25
25-30
30-35
>35
BMI (kg/m2)

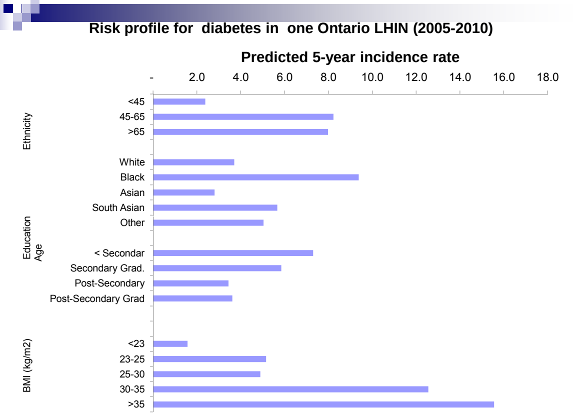

10-year risk (%) of DM by BMI category in Canada
Male Risk (%)
Female Risk (%)
Male # of Cases
404,457
288,074
242,132
202,369
116,537
129,266
90,849
60,114
10-yr risk (%)
# of DM Cases
600,000
400,000
200,000
0
<23
23-25
25-30
30-35
>35
BMI (kg/m2)


10-year risk (%) of DM in Canada by Education
Males
Females
10-yr risk (%)
20.0
10.0
0.0
13.6
11.4
9.5
8.4
7.1
5.9
7.3
5.8
< than secondary
Secondary school grad.
Other post-secondary
Post secondary grad.

DPoRT & Interventions in SES groups

- Given the high baseline risk of diabetes in lower SES populations, this group has more to benefit from interventions to prevent diabetes
- Use DPoRT to estimate the future risk of diabetes across socioeconomic strata and to assess how prevention interventions may influence social disparities in risk
- Closely examine the impact of adherence to health interventions on this disparity in risk

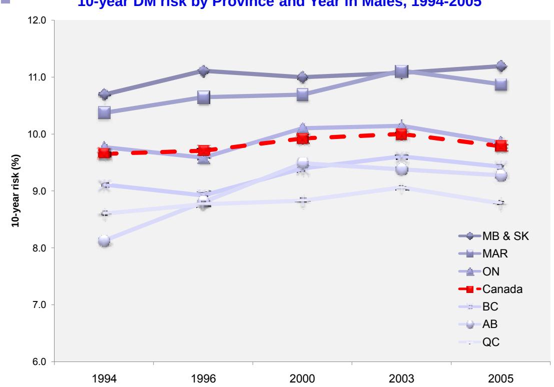




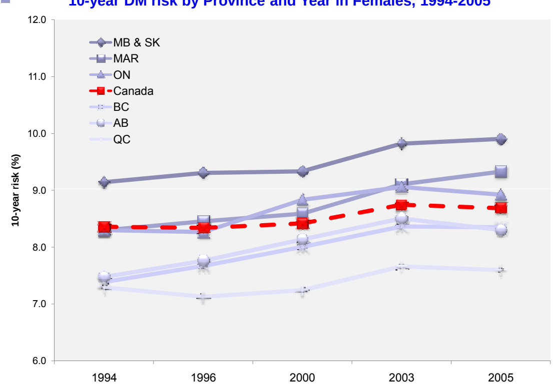
Why is prediction important to the health planner?

Because things are changing...

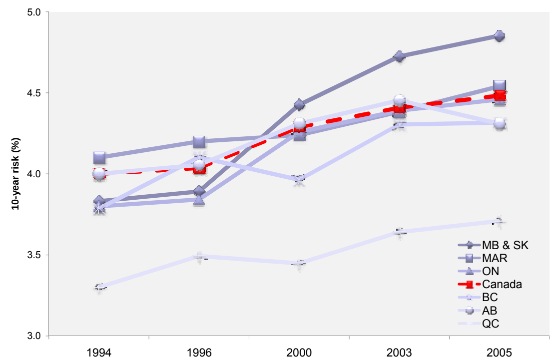
10-year DM risk by Province and Year in Males, 1994-2005



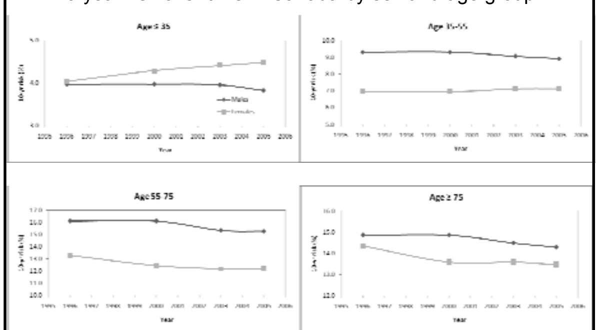
10-year DM risk by Province and Year in Females, 1994-2005



10-year DM risk by Province and Year in Females <35, 1994-2005



10-year risk over time in Canada by sex and age group

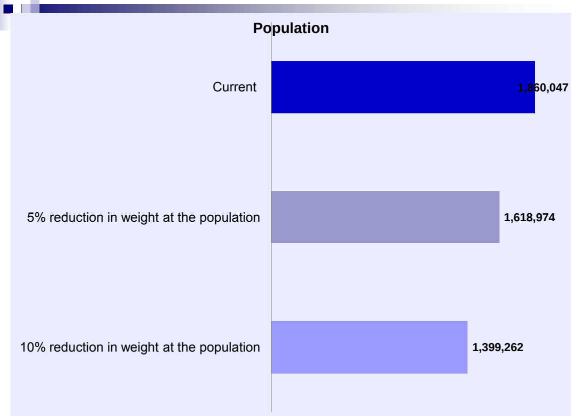


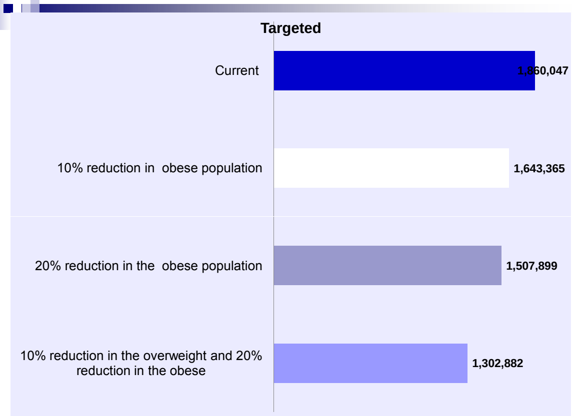
Interventions

- Quantifying the impact of changes in baseline risk gives important insight into the distribution of risk in the population

International Diabetes Federation (IDF) consensus on the prevention of type 2 diabetes

- IDF consensus reviewed available evidence on the major risk factors for diabetes and the benefits that can be achieved by interventions
- Based on their findings they developed recommendations for 2 groups: people at high risk and the entire population
- Recommends a 5-10% weight reduction in general population





Measurement

Limitations of DPoRT

- Reliance on self-report measures
- Use of physician-diagnosed diabetes as an outcome
- Does not apply to those <19 years of age, institutionalized, or on reserve.

Measurement Issues

- Self-reported height and weight
- BMI
- Ethnicity
- Physician-diagnosed diabetes

Central Obesity and Diabetes

- Vazquez et al. Comparison of Body Mass Index, Waist Circumference, and Waist/Hop ratio in Predicting Incident Diabetes: A Meta-Analysis. Epidemiologic Reviews. 2007 (29) 115-128
- From the clinical perspective central obesity generates "diabetogenic" substances thus is thought to be more informative for predicting incident DM

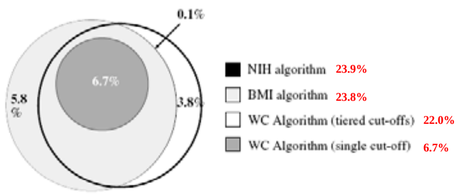
Vazquez et al. Epidemiologic Reviews. 2007 (29) 115-128

- Meta analysis demonstrated that the relative risks associated with BMI, Waist circumference and waist/hip ratios were all similar: (RRs =1.87, 1.87, 1.88)
- "Because of their high correlation, from the statistical perspective, body mass index and waist circumference are unlikely to yield different answers"
- "Although from the clinical perspective focusing on central obesity is appealing, further research is needed to determine the usefulness of waist circumference or waist/hip over BMI"

Application of obesity treatment algorithms to Canadian adults

- National Institutes of Health (NIH) proposed a treatment algorithm using BMI, waist circumference and CVD risk factors to help health practitioners identify patients that would benefit from weight loss treatment
- Debate about the clinical utility of these measures (Kiernan & Winkleby 2000 Arch. Intern. Med.)
- Alternative algorithms use only BMI or waist circumference

Proportion of the Canadian population meeting the criteria for weight loss treatment according to the four algorithms.



•Note that because only 0.1% of the population is captured by the NIH algorithm and is missed when using the BMI algorithm
• The circle representing the NIH algorithm is almost completely eclipsed by the BMI circle.

(Mason and Katzmarzyk, 2005)

Limitations of variable constraints

- Additional clinical predictors (fasting blood glucose and family history) are not included in DPoRT because they are not consistently, accurately or systematically measures in populations.
- In a clinical setting it is feasible to capture this information from simple routine measurements and lab tests.
- How much of a problem does this pose?

Limits to Discrimination

- As seen in other studies, simplified models perform as well or in some cases better than full models and improvements to discrimination with increasing predictors become negligible

- Chambless LE, Heiss G, Shahar E, Earp M, Toole J. Prediction of ischemic Stroke Risk in the Atherosclerosis Risk in Communities Study. American Journal of Epidemiology 2004; 160(3):259-269.
- Ambler G, Brady AR, Royston P. Simplifying a prognostic model: a simulation model based on clinical data. Statistics in Medicine 2002; 21:3803-3822.
- Wilson PWF, D'Agostino RB, Levy D, Belanger AM, Silbershatz H, Kannel WB. Prediction of coronary heart disease using risk factor categories. Circulation 1998; 97:1837-1847.

ORIGINAL INVESTIGATION

Prediction of Incident Diabetes Mellitus in Middle-aged Adults

The Framingham Offspring Study

Peter W. F. Wilson, MD; James B. Meigs, MD, MPH; Lisa Sullivan, PhD;
Caroline S. Fox, MD, MPH; David M. Nathan, MD; Ralph B. D'Agostino, Sr, PhD

•Clinical prediction rule from the Framingham study that included several physical measures and complex clinical variables for 7-year risk of T2DM in middle aged-adults

•Discrimination was slightly higher when using BMI as measure of obesity over waist circumference and discrimination BMI model stayed exactly the same when waist circumference

•Discrimination from complex clinical model (i.e. including C reactive protein, 2-hour OGTT, various insulin sensitivity indices, HOMA β-cell index ect..) versus simple clinical model did not improve discrimination, actually decreased slightly in some permutations

A Coronary Heart Disease Risk Score Based on Patient-Reported Information

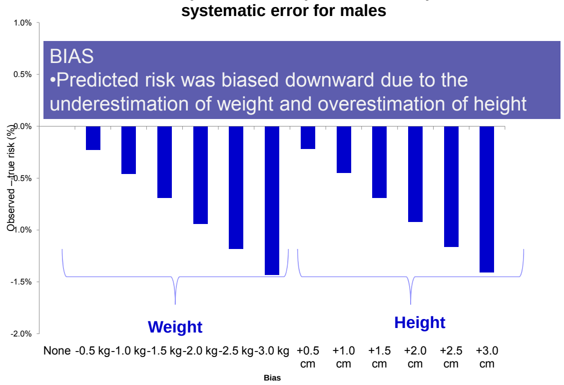
Arch G. Mainous III, PhD[a,b,*], Richelle J. Koopman, MD, MS[a], Vanessa A. Diaz, MD, MS[a],
Charles J. Everett, PhD[a], Peter W.F. Wilson, MD[c], and Barbara C. Tilley, PhD[b]

- Self-report algorithm for CHD (Mainous et al, American Journal if Cardiology, 2007)
- 10-year CHD risk is similar in predictive ability to that of the Framingham Heart Score and to the European SCORE algorithms

Self-reported height and weight

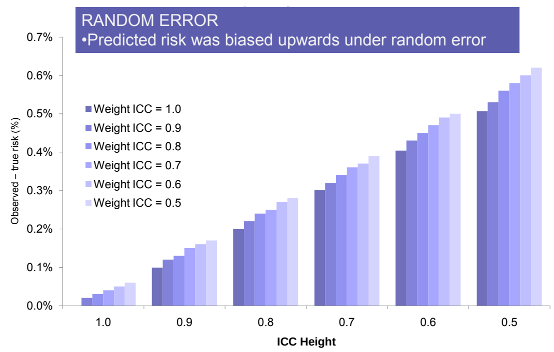
- Shields et al. (2008) examined agreement between self-report and measures BMI in a sub-sample of the CCHS population
- DPoRTs' discrimination and calibration would be minimally affected at these levels

Difference in predicted risk (observed - true) under systematic error for males



BIAS
•Predicted risk was biased downward due to the underestimation of weight and overestimation of height

Difference in predicted risk (observed - true) under various levels of random error for



RANDOM ERROR
•Predicted risk was biased upwards under random error

Ethnicity

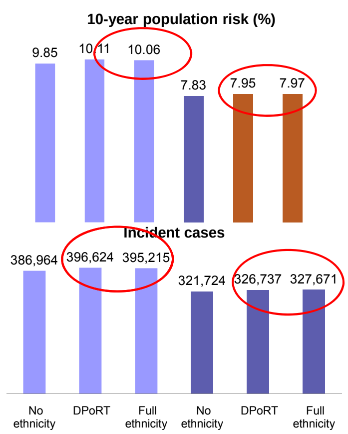
- High risk ethnic groups outlined by diabetes screening guidelines are: people of Aboriginal, Hispanic, south Asian, Asian, or African descent)
- Currently DPoRT only examined ethnic grouping as “white/non-white”
- Compared DPoRT with a modified version which includes detailed ethnic information to determine its impact/relevance for estimating population diabetes risk

(1) DPoRT minus ethnicity – called “no ethnicity”

(2) DPoRT (white/non-white)

(3) DPoRT plus detailed ethnic information – called “Full model” (6 ethnic categories)

- All models produced similar C statistics (differing only at the 0.01 place
- Accuracy achieved(defined by H-L) in a validation cohort using all algorithms except the one with full ethnicity in males



Physician-diagnosed diabetes

- Advocates argue that it is meaningful to both people with diabetes and health care system
- “True” prevalence of diabetes is estimated to be higher due to significant under-diagnosed population
- Risk tool can re-calibrated to predict “true” diabetes

Conclusions

- DPoRT was successful validated in two external validation cohorts and demonstrated good discrimination and calibration
- Predictive tools allow us to empirically estimate the future risk and number of new cases of diabetes in a population
- Tool can be applied to quantify impact that changes in risk factors will have on future diabetes incidence

Future work

- Calibration/validation within minority populations
- Case ascertainment/testing between provinces
- Differential error in height and weight with respect to risk status

Future work

- Validating the growth model for predicting obesity in the Canadian population
- Putting DPoRT in the hands of health planners
- Collaboration with other models

Microimulation Models

- Computer models that operate at the level of the individual behavioural entity
- Simulate large representative populations of these low-level entities in order to draw conclusions that apply to higher levels of aggregation such as an entire country
- DPoRT is currently being utilized within CVD microsimulation to predict transition states

THANK YOU

Questions? Comments?

The School Health Action, Planning & Evaluation System (SHAPES)

Dr. Scott Leatherdale
Scientist & Research Chair

Department of Population Studies & Surveillance
Cancer Care Ontario

Better cancer services every step of the way

Overview

- Background on the current cancer problem in Canada
- Background on the SHAPES data collection system
- Examples of SHAPES research & surveillance activities
- Examples of some research findings

2

Acknowledgements

- Centre for Behavioural Research and Program Evaluation (CBRPE) of the Canadian Cancer Society (CCS)

  Canadian Cancer Society / Société canadienne du cancer

  National Cancer Institute of Canada / Institut national du cancer du Canada

- Population Health Research Group, University of Waterloo

  PHR population health research group

- Research collaborators:
  Dr. Roy Cameron & Dr. Steve Manske

3

Cancer problem in Canada

- It is estimated that there will be **166,400** new cases of cancer and **73,800** deaths from cancer in Canada in 2006.
  - more new cases than the entire population of PEI
  - more deaths than the populations of Moose Jaw and Prince Albert

4

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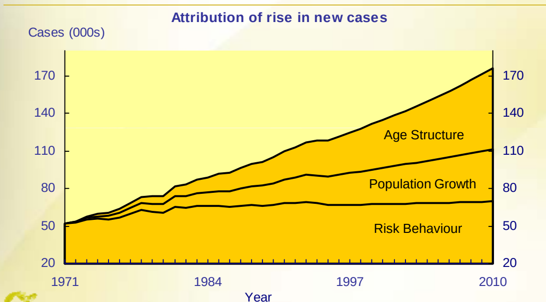
  - more new cases than the entire population of PEI
  - more deaths than the populations of Moose Jaw and Prince Albert

	New Cases	Deaths
ALL	*166,400*	*73,800*
Lung (men & women)	23,900	20,200
Breast (women)	22,400	5,400
Prostate (men)	24,700	4,300
Colorectal (men & women)	21,500	8,900

CCS, 2008

5

Increasing cancer burden



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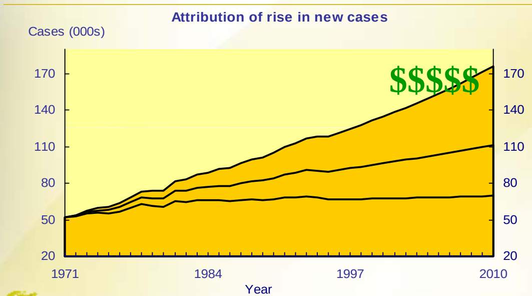
How expensive is cancer?

- The total cost of cancer in Canada was estimated to be $14.2 billion in 1998.
  - Direct cost of health care services was $2.5 billion
  - Indirect cost due to mortality and lost productivity was $11.7 billion
- Future costs will increase dramatically as a result of the infrastructure demands required for treating cancer (e.g., hospitals, oncologists).

7



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Conservative estimates suggest….

- Over the next 30 years:
  - the Canadian economy is expected to lose over $540 billion in wage-based productivity due to cancer;
  - The Federal and Provincial governments combined are expected to lose over $248 billion in tax revenues as a result of cancer disability; and,
  - the direct health care costs associated with cancer are expected to exceed $176 billion over the same period.

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Major causes of cancer

- Major causes of cancer are:
  1. Smoking
  2. Physical Inactivity
  3. Poor Nutrition
- These three factors account for over 50% of all cancers.

Colditz et al., 1996

10

Major causes of cancer

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  1. Smoking
  2. Physical Inactivity
  3. Poor Nutrition
- These three factors account for over 50% of all cancers.

Colditz et al., 1996

- Conceptually, this means that ½ of all the cancer deaths in Canada are potentially preventable if changes in these risk behaviours were to occur.
- As such, even if only modest population-level improvements in these behaviours were to occur, it could prevent tens of thousands of deaths over the next decade.

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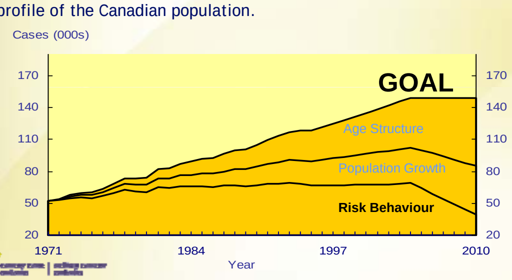
- The only way to accomplish this goal is to change the risk behaviour profile of the Canadian population.



12

My attempt to shift the risk profile

- Although individual-based approaches are important, they are likely insufficient for causing the population-level shifts required to dramatically reduce the impending cancer burden.

13

My attempt to shift the risk profile

- Although individual-based approaches are important, they are likely insufficient for causing the population-level shifts required to dramatically reduce the impending cancer burden.
- The focus of my research is twofold:
  1. understanding the association between environment contexts (both social and physical environments) and cancer risk behaviour; and
  2. developing systems to improve the uptake of evidence-based practices in population-based cancer control prevention programming.

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School Health Action, Planning & Evaluation System

- A school-based data collection system designed to inform and guide
  - the development,
  - the evaluation,
  - and targeting

  of programs and policies designed to reduce risk behaviours and promote healthy behaviours among youth.

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School Health Action, Planning & Evaluation System

- A school-based data collection system designed to inform and guide
  - the development,
  - the evaluation,
  - and targeting

  of programs and policies designed to reduce risk behaviours and promote healthy behaviours among youth.

- Rationale for developing SHAPES
  - facilitate applied research and knowledge exchange within schools
  - minimize burden on school personnel and students yet maximize value to schools and stakeholders
  - **understand what works, for whom, and in what context.**

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Conceptual Model

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Background

- The SHAPES system involves:
  1. administration of school-based student questionnaire(s) to assess youth behaviour and correlates of behaviour,
  2. school-level administrator surveys to measure the presence and implementation of school policies and programs, and resources related to the behaviour being examined, and,
  3. the generation of school-level feedback reports which can be used by schools and local health agencies to plan and evaluate programs and interventions.

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School Health Action, Planning & Evaluation System

- Existing SHAPES Modules address:
  - Physical Activity and **Obesity** (*Physical Activity Module*)
  - Eating Behaviour *(Healthy Eating Module)*
  - Tobacco Use (*Tobacco Module*)
  - Mental Fitness (*Scales assessing Needs Satisfaction, Affect, Prosocial Behaviour, Social Responsiveness)*

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Student-Level Data

- Research tools have been developed and tested to collect physical activity/obesity and tobacco use data at the **student**-level.
  - ✓ **For example: Physical Activity Questionnaire**

20

Student-Level Data

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  - ✓ **For example: Physical Activity Questionnaire**

4-Page Questionnaire

Designed to collect data from every student in a school pertaining to:

- physical activity/inactivity patterns,
- height / weight (used to calculate BMI)
- correlates for physical activity,
- enabling factors within the school.

It is machine readable, so data can be scanned directly into a computer.

Also measures smoking behaviour.

Wong, Leatherdale, Manske. MSSE 2006;38(9):1593-1600.

School-Level Data

- Research tools have been developed and tested to collect data about school programs, policies and resources related to physical activity and tobacco use at the **school**-level.
- For example: *School Health Environment Survey (SHES)*
  - 7-page questionnaire
  - Designed to be completed by a school administrator(s).
  - Measures different types of physical activity policies and the different aspects of physical activity programming built into the school curriculum.
  - Also collects data pertaining to the different physical activity resources/equipment that are available within a school.

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Knowledge Exchange Tool: **Student-level data**

- Customized school specific feedback reports have been developed to transfer the **student**-level data back to school and public health stakeholders.

23

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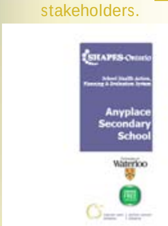

- A computer-generated report provided to school administrators & public health.
- Summarizes school level findings for physical activity.
- Provides evidence-based suggestions for interventions that are designed to increase physical activity levels and decrease sedentary behaviour of *their* student population.
- Facilitate knowledge exchange between the school stakeholders and 'us', the researchers.

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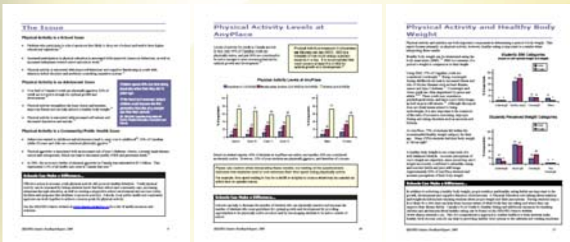

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Knowledge Exchange Tool: **School-level data**

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26

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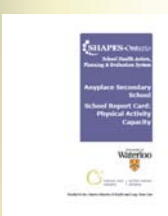
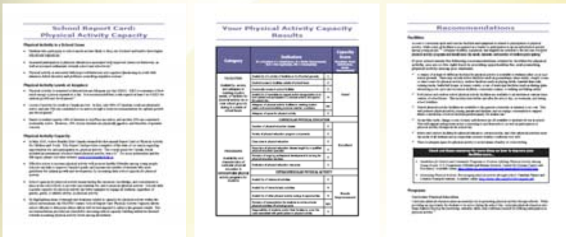


- A computer-generated report provided to school administrators.
- Provides schools with feedback on the strengths and weaknesses of their health policies and programs, and facilities and resources based on research evidence
- Provides resources to help schools take the next steps in learning how to effectively adopt or revise school health policies and programs to promote PA.
- Facilitate knowledge exchange between the school stakeholders and 'us', the researchers

27



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Research Activities

- Demand for SHAPES is high.
- Since 2000, SHAPES has been completed by over 550,000 students in more than 2,000 schools in Canada.
- These projects have been initiated by:
  1. Researchers,
  2. Decision makers, and
  3. School stakeholders.

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Research Activities *(highlights)*

SHAPES-Ontario

- In 2006, the Ontario Ministry of Health Promotion used SHAPES to inform planning activities associated with the Healthy Eating and Active Living (HEAL) Strategy and the Ontario Tobacco Strategy (OTS)
- The Physical Activity and Tobacco Modules were completed by over 69,000 students in grades 9 to 12 attending 81 secondary schools in the Province of Ontario.
- Currently working with Dr. Susan Elliott to incorporate built environment data for the 81 schools

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Research Activities *(highlights)*

PLAY-Ontario

- In 2008, the Ontario Heart & Stroke Foundation used SHAPES to inform planning activities associated with their provincial strategy around physical activity and healthy weights (Targeting Obesity)
- Physical Activity Module was completed by:
  - 2,187 students in grades 1 to 4
  - 2,601 students in grades 5 to 8
- attending 30 elementary schools in the Province of Ontario.
- Objectively measured height, weight and waist circumference.

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Research Activities *(highlights)*

SHAPES-New Brunswick

- In 2007, Health Canada and the New Brunswick Department of Education and Department of Wellness, Culture and Sport used SHAPES to inform their planning activities associated with the New Brunswick Improving Student Wellness Strategy
- The Physical Activity and Tobacco Modules were completed by over 33,000 students in grades 6 to 12 attending 184 middle and secondary schools in the Province of New Brunswick.

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Research Results *(highlights)*

Table 3. Adjusted Odds of Being Overweight, by Behavioral Category, Male (n = 2,083) and Female (n = 1,526) Students, School Health Action, Planning and Evaluation System (SHAPES), Ontario, Canada, 2005-2006

Behavioral Category	Overweight boys (n = 268) vs Normal Weight and Underweight* Students (n = 1,815), AOR† (95% CI)	Overweight girls (n = 225) vs Normal Weight and Underweight* Students (n = 1,299)‡, AOR† (95% CI)
High active-low sedentary	1 (reference)	1 (reference)
High active-high sedentary	1.15 (0.71-1.88)	➡ 1.91 (1.01-3.61)§
Low active-low sedentary	1.16 (0.58-2.30)	1.53 (0.78-2.99)
Low active-high sedentary	➡ 1.60 (1.01-2.58)*	➡ 2.24 (1.23-4.09)¶

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.
* Students who were less than the 5th percentile for BMI by sex were classified as underweight, students who were in the 85th percentile or higher for BMI by sex were classified as at risk of overweight/overweight, and students who were in the 5th to less than the 85th percentile for BMI by sex were classified as normal weight.
† Odds ratios adjusted for age and clustering by school.
‡ Numbers do not add to total because of missing values.
§ P = .048.
* P = .045.
¶ P = .009.

Wong & Leatherdale, 2009

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Research Results *(highlights)*

Table III. Multivariate logistic regression analyses examining sedentary behaviours as a function of physical activity, weight and weight concerns, social influences, smoking and school location among male students (n = 12,806).

		Adjusted Odds Ratio [§†] (95% CI)		
		Screen Time ≥2 hours vs. <2 hours[a]	Reading ≥1 hour vs. <1 hour[b]	Homework ≥1 hour vs. <1 hour[c]
Physical activity level	High active	1.00	1.00	1.00
	Moderately active	0.94 (0.85,1.04)	1.09 (0.99,1.20)	1.36 (1.23,1.50)***
	Low active	1.35 (1.15,1.58)***	0.92 (0.80,1.07)	1.12 (0.98,1.29)
BMI (kg/m^2)	Normal weight	1.00	1.00	1.00
	Underweight	1.23 (1.01,1.50)*	1.19 (1.00,1.43)*	1.05 (0.87,1.28)
	At risk of overweight	1.11 (0.97,1.26)	0.89 (0.78,1.01)	0.75 (0.65,0.85)***
Parent encouragement of physical activity	Encourage	1.00	1.00	1.00
	Strongly encourage	0.80 (0.73,0.87)***	1.07 (0.98,1.17)	1.05 (0.95,1.16)
	Do not encourage	0.99 (0.89,1.11)	0.87 (0.78,0.97)*	0.74 (0.66,0.82)***
Parent support of physical activity	Supportive	1.00	1.00	1.00
	Very supportive	0.88 (0.80,0.96)**	1.03 (0.95,1.13)	1.23 (1.12,1.35)***
	Unsupportive	1.07 (0.90,1.26)	1.30 (1.11,1.52)**	0.76 (0.65,0.88)***
Number of close friends who are active	None	1.00	1.00	1.00
	1–2	0.96 (0.77,1.21)	1.12 (0.91,1.38)	1.59 (1.28,1.98)***
	3 or more	0.79 (0.64,0.97)*	0.99 (0.81,1.20)	1.80 (1.47,2.19)***
Smoking status	Non-smoker	1.00	1.00	1.00
	Occasional smoker	0.97 (0.84,1.11)	0.75 (0.65,0.86)***	0.60 (0.53,0.69)***
	Daily smoker	0.83 (0.72,0.96)*	0.54 (0.47,0.62)***	0.34 (0.29,0.39)***

Leatherdale & Wong, 2008

Research Results *(highlights)*

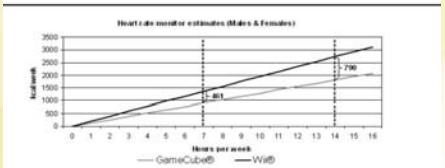
Table IV. Multivariate logistic regression analyses examining sedentary behaviours as a function of physical activity, weight and weight concerns, social influences, smoking and school location among female students (n = 12,254).

		Adjusted Odds Ratio [§†] (95% CI)		
		Screen Time ≥2 hours vs. <2 hours[a]	Reading ≥1 hour vs. <1 hour[b]	Homework ≥1 hour vs. <1 hour[c]
Physical activity level	High active	1.00	1.00	1.00
	Moderately active	0.71 (0.63,0.80)***	1.08 (0.95,1.22)	1.41 (1.21,1.63)***
	Low active	0.85 (0.73,0.99)*	0.97 (0.83,1.13)	1.38 (1.15,1.65)**
BMI (kg/m^2)	Normal weight	1.00	1.00	1.00
	Underweight	1.01 (0.85,1.22)	0.98 (0.81,1.18)	1.23 (0.97,1.55)
	At risk of overweight	1.24 (1.10,1.41)***	1.19 (1.05,1.35)**	0.95 (0.82,1.10)
Parent encouragement of physical activity	Encourage	1.00	1.00	1.00
	Strongly encourage	0.76 (0.69,0.83)***	0.99 (0.91,1.10)	1.24 (1.09,1.39)**
	Do not encourage	1.14 (1.03,1.27)*	0.89 (0.80,1.00)	0.75 (0.66,0.84)***
Parent support of physical activity	Supportive	1.00	1.00	1.00
	Very supportive	0.81 (0.75,0.89)***	1.04 (0.95,1.14)	1.44 (1.30,1.61)***
	Unsupportive	0.96 (0.82,1.12)	0.85 (0.73,0.99)*	0.94 (0.79,1.11)
Number of close friends who are active	None	1.00	1.00	1.00
	1-2	0.77 (0.63,0.94)*	1.27 (1.04,1.54)*	1.36 (1.10,1.69)**
	3 or more	0.67 (0.55,0.82)***	1.46 (1.20,1.77)***	1.68 (1.35,2.07)***
Smoking status	Non-smoker	1.00	1.00	1.00
	Occasional smoker	1.11 (0.97,1.27)	0.73 (0.64,0.84)***	0.52 (0.44,0.59)***
	Daily smoker	0.98 (0.85,1.13)	0.49 (0.43,0.56)***	0.27 (0.23,0.31)***

Leatherdale & Wong, 2008

Research Results *(highlights)*

Figure 1
Weekly Energy Expenditure Estimates for Playing Inactive (GameCube®) and Active (Wii®) Videogames According to Heart Rate Monitor Data



Leatherdale et al., 2010

Research Results *(highlights)*

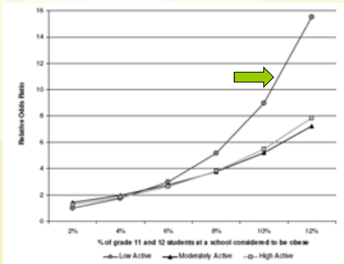


Figure 2
Model-based estimated odds ratio for a junior student being obese versus a normal weight as a function of the prevalence of obese senior students at a school and physical activity.

Leatherdale et al., 2010

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Next Steps

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Next Steps

Ecological Measures / Built Environment

- Research has identified that the characteristics of the communities where people live are associated with their cancer risk behaviours.
- This variability can be a function of:
  - *modifiable* factors, such as policies and programs within a community, or the physical characteristics of a community.
  - *non-modifiable* factors such as the characteristics of the individuals situated within the community or the geographic location of a community.

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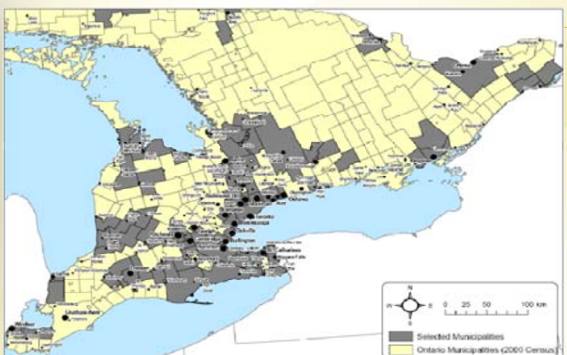
Next Steps

- Research has identified that the characteristics of the communities where people live are associated with their cancer risk behaviours.
- This variability can be a function of:
  - *modifiable* factors, such as policies and programs within a community, or the physical characteristics of a community.
  - *non-modifiable* factors such as the characteristics of the individuals situated within the community or the geographic location of a community.
- Understanding the community characteristics associated with cancer risk behaviours would provide valuable insight for researchers and practitioners interested in targeting and/or tailoring future prevention initiatives where they are most likely to have impact.

Municipalities in Southern Ontario



Primary data sources

- DMTI Spatial
  - CanMap RouteLogistics (CMRL)
  - Enhanced Points of Interest (EPOI)
- Ontario Ministry of Municipal Affairs and Housing
- Census Canada

DMTI Spatial

- A geographic information system (GIS) data resource.
- CanMap RouteLogistics (CMRL)
  - high quality street map data
    - e.g., street road networks and road classifications, trails, bridges and tunnels, land use types (residential, industrial, institutional, parks), and bodies of water.

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DMTI Spatial

- A geographic information system (GIS) data resource.
- CanMap RouteLogistics (CMRL)
  - high quality street map data
    - e.g., street road networks and road classifications, trails, bridges and tunnels, land use types (residential, industrial, institutional, parks), and bodies of water.
- Enhanced Points of Interest (EPOI)
  - a database of business and recreational points of interest
    - e.g., education facilities, golf courses, health care facilities, police and fire stations, industrial facilities, food stores, eating and drinking places, and recreation facilities.

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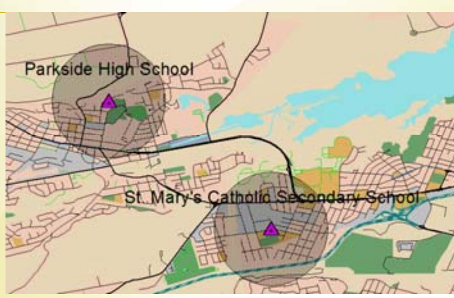
DMTI Spatial



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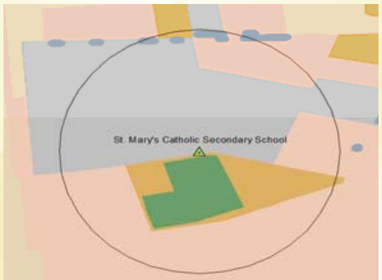
DMTI Spatial



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Ontario Ministry of Municipal Affairs and Housing

- The OMMAH houses the Financial Information Return (FIR) for all Ontario municipalities.
- The FIR data are updated by each municipality annually.
  - examples of FIR data include:
    - square meters of outdoor recreation space (total / per 1000 persons)
    - crime statistics (violent / property / youth / total)
    - total participant hours for recreation programs per 1000 persons
    - operating cost for police/fire services per person
    - operating costs for parks and recreation facilities per person
    - total kilometres of trails (total / per 1000 persons)
    - square meters of outdoor / indoor recreation space (total / per 1000 persons)
    - municipal transit system (type, cost for users).

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Census Canada

- The 2006 Census Community Profiles provide municipal-level sociodemographic information from the 2006 Census of population.
  - Available data in these community profiles include:
    - age and sex
    - education (including educational attainment)
    - ethnic origin and visible minorities
    - families and households
    - housing and shelter costs
    - income and earnings
    - labour (including labour market activity, industry and occupation)
    - language (including language of work)
    - place of work and commuting to work (including mode of transportation)
    - population and dwelling counts.

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Thank You

Questions?

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(416) 971-9800 ext 3237

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The Role of Gestational Diabetes in the Epidemic of Type 2 Diabetes Among Saskatchewan First Nations People

Roland Dyck
Department of Medicine

GDM and T2DM in Saskatchewan FN People

- A brief overview of gestational diabetes (GDM)
- Epidemiology of type 2 diabetes in Saskatchewan
- Early insights –
  - Emergence of GDM in Northern Saskatchewan
  - Changing birth weight profiles in Northern Saskatchewan
- The relationship between high birth weight and T2DM
- FN ethnicity and GDM
- Differences in T2DM rates by sex among FN
- Summary and conclusions

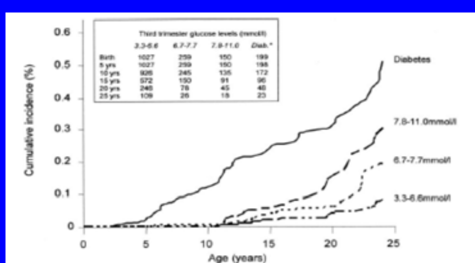
A Brief Overview of Gestational Diabetes

- A type of diabetes that first appears or is first diagnosed during pregnancy
- Described and characterized in the 1970's
- Routine screening began in 1980's
- Present in about 3% of pregnancies in Canada
- ↑ risk if women older, previous GDM, previous stillbirth, previous infant with high birth weight, family history of diabetes, pre-pregnancy obesity, some ethnic groups
- Adverse Outcomes:
  - <u>immediate</u>: macrosomia, birth trauma, metabolic
  - <u>long term</u>: ? risk factor for T2DM in women & offspring

Long Term Consequences of GDM

- <u>Intra</u>-generational – women with GDM at higher risk for later T2DM:
  - * 10% have T2DM immediately following pregnancy
  - * most have GDM in subsequent pregnancies
  - * T2DM incidence 5-10% per year after index pregnancy
- <u>Inter</u>-generational – offspring of diabetic mothers have increased childhood obesity & possible risk for later T2DM
  - * first reported among Pima Indians
  - * difficult to corroborate in other populations
    (most offspring of diabetic mothers born since 1980's younger than 30 – few will have T2DM)

Effect of Maternal Glycemic Control on T2DM Incidence among Pima Indians



Source: Franks et al. (2006), *Gestational Glucose Tolerance and Risk of Type 2 Diabetes in Young Pima Indian Offspring*

Long Term Consequences of GDM

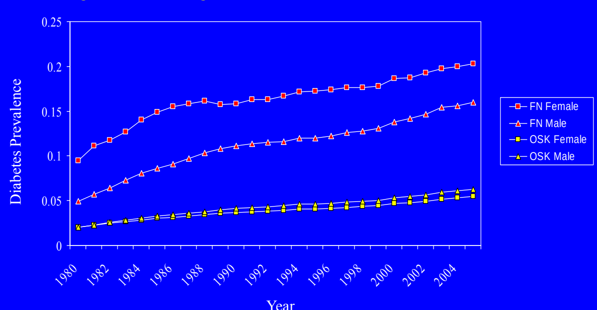
- Why is it important?
  - * May contribute to increasing rates of T2DM in some populations
  - * May provide insights into mechanisms underlying T2DM
  - * May offer unique opportunities for 1° prevention of T2DM

Long Term Consequences of GDM

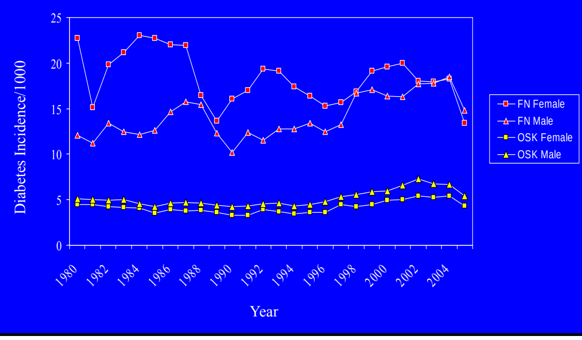
- Approaches to determining its impact
  - * Prospective longitudinal studies
  - * Animal models
  - * Inferential epidemiological studies using GDM proxies and other indirect measures
  - * Computer models

First…What we know about the epidemiology of diabetes in Saskatchewan

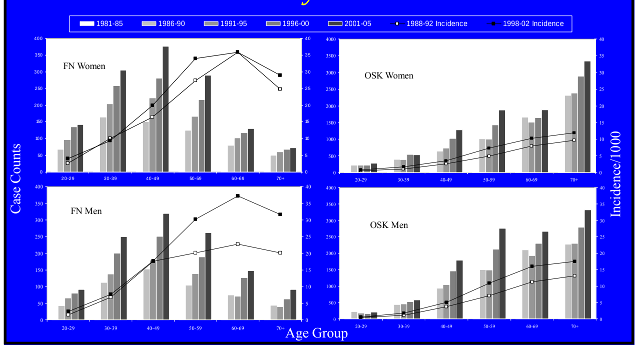
Age Standardized Diabetes Prevalence by Ethnicity and Sex - Saskatchewan



Age Standardized Diabetes Incidence by Ethnicity and Sex - Saskatchewan



Age Specific Diabetes Incident Case Counts and Incidence by Time Period

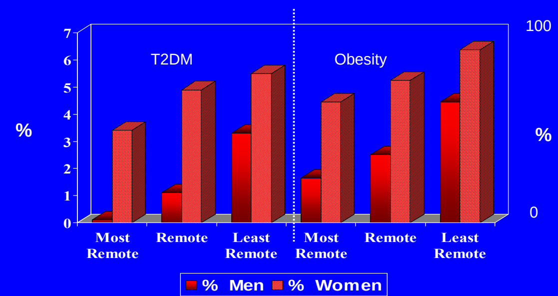


What we know about the epidemiology of diabetes in Saskatchewan

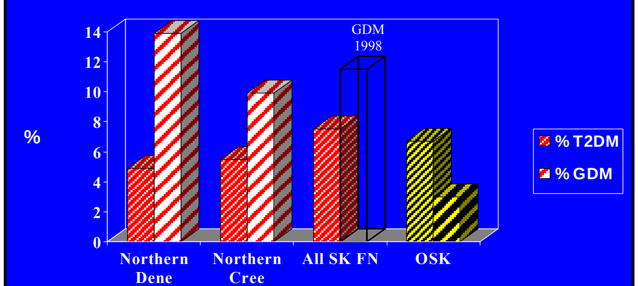
- First Nations people have higher diabetes prevalence and incidence than others
- First Nations women have higher diabetes prevalence and incidence than men
- Diabetes occurs at younger ages in First Nations people
- Young First Nations women experience a higher burden of diabetes than men

Early insights…emergence of GDM in northern Saskatchewan First Nations communities

Crude Rates of T2DM and Obesity among Adults by FN Community-1991

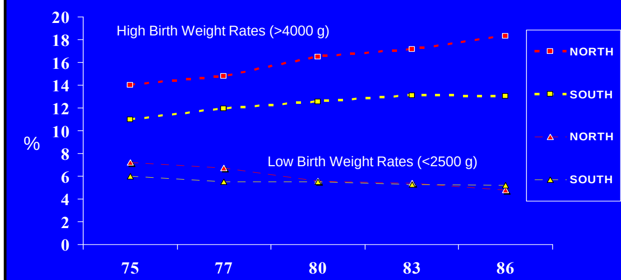


Crude Rates of Diabetes & Gestational Diabetes Among FN Women by Community-1990/91



Early insights…birth weights in northern Saskatchewan First Nations communities

High and Low Birth Weight Rates - Northern (FN) & Southern (OSK) SK



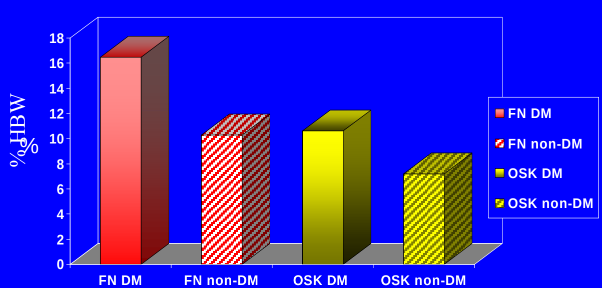
Early Insights - summary

- Prevalence of obesity and T2DM inversely related to remoteness of FN communities
- FN women have higher prevalence of obesity and T2DM than men
- High rates of GDM appear before significant occurrence of T2DM
- Increase in high birth weight rates have paralleled emergence of obesity & GDM in women

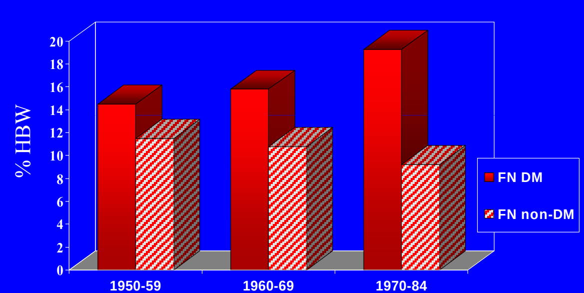
Next steps…1) The relationship between high birth weight and T2DM in Saskatchewan

- If GDM increases diabetes risk in next generation, is this reflected in higher birth weights among FN with diabetes?

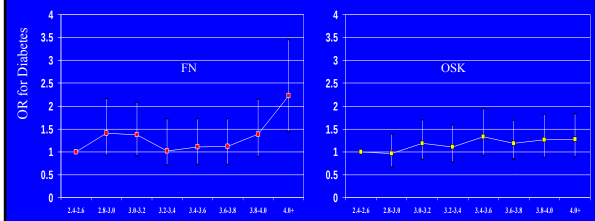
% High Birth Weight (>4000g) Diabetic FN vs Control Groups



% High Birth Weight by Birth Year - Diabetic vs non-Diabetic FN



OR's for diabetes according to birth weight – FN and OSK

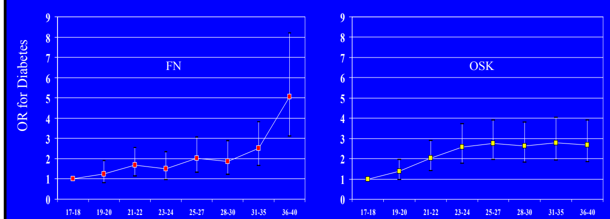


FN	2.4-2.6	2.8-3.0	3.0-3.2	3.2-3.4	3.4-3.6	3.6-3.8	3.8-4.0	4.0+
Cases	84	95	101	81	90	83	89	122
Controls	109	103	103	97	108	106	103	71

OSK	2.4-2.6	2.8-3.0	3.0-3.2	3.2-3.4	3.4-3.6	3.6-3.8	3.8-4.0	4.0+
Cases	115	120	120	123	123	134	127	128
Controls	133	140	118	127	109	130	118	119

Birth Weight Quantiles (kg)

OR's for Diabetes according to Maternal Age – FN and OSK



FN	17-18	19-20	21-22	23-24	25-27	28-30	31-35	36-40
Cases	91	77	88	72	100	85	117	115
Controls	162	117	99	95	100	93	86	48

OSK	17-18	19-20	21-22	23-24	25-27	28-30	31-35	36-40
Cases	111	91	114	121	173	127	136	117
Controls	219	133	115	100	130	100	103	94

Maternal Age Quantiles (years)

HBW and T2DM - summary

- HBW is a significant predictor for T2DM among FN
- The proportion of diabetic FN with HBW has increased with more recent birth cohorts
- It is likely that this relationship is largely due to impact of GDM since both HBW and increasing maternal age are associated with GDM
  - * e.g. 35% of FN newborns are macrosomic

Next steps…2) Exploring the relationship of GDM with FN ethnicity

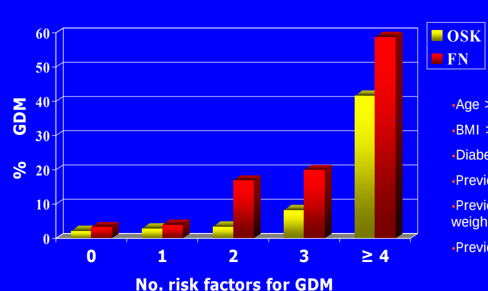
- Are possible differences in GDM rates due to differences in GDM risk profiles and/or on basis of ethnicity?

Rates of GDM by Ethnicity

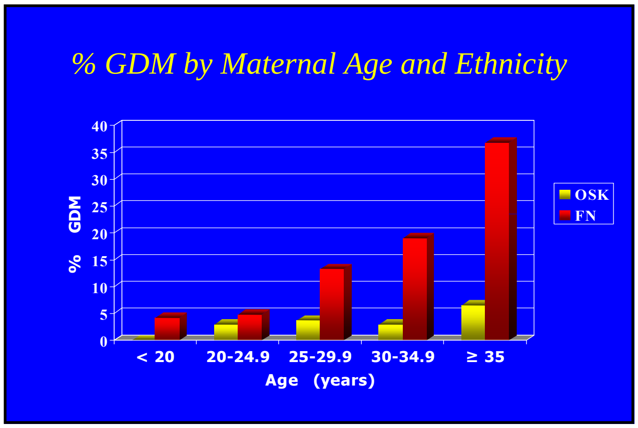
Residence	OSK		FN		OR (FN:OSK)
In SHR	3.7	38/1039	6.4	11/173	1.8 (0.9, 3.6)
Outside SHR	3.1	10/321	22.8	18/79	9.2 (4.0, 20.8)*
Overall	3.5	48/1360	11.5	29/252	3.6 (2.2, 5.8)*

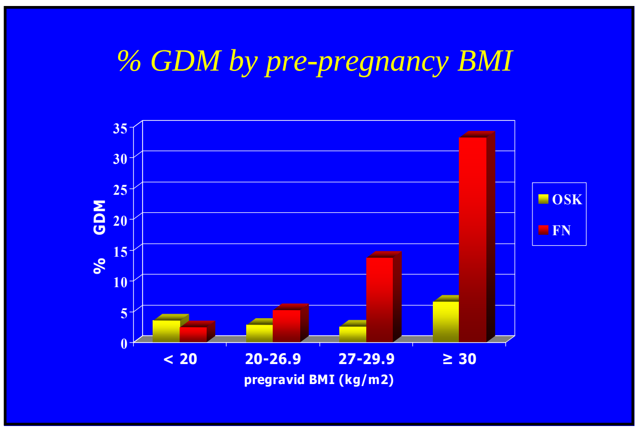
* P < 0.001

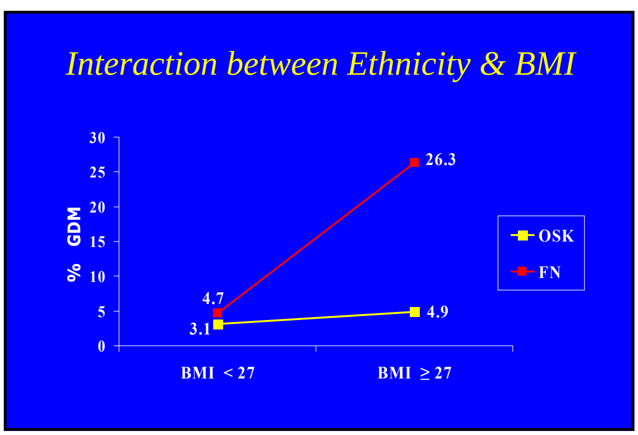
% GDM by number of risk factors for GDM



- Age >= 30
- BMI >= 27
- Diabetes in family
- Previous GDM
- Previous high birth weight infant
- Previous stillbirth


% GDM by Maternal Age and Ethnicity
% GDM
40
35
30
25
20
15
10
5
0
OSK
FN
< 20
20-24.9
25-29.9
30-34.9
≥ 35
Age (years)


% GDM by pre-pregnancy BMI
% GDM
35
30
25
20
15
10
5
0
OSK
FN
< 20
20-26.9
27-29.9
≥ 30
pregravid BMI (kg/m2)

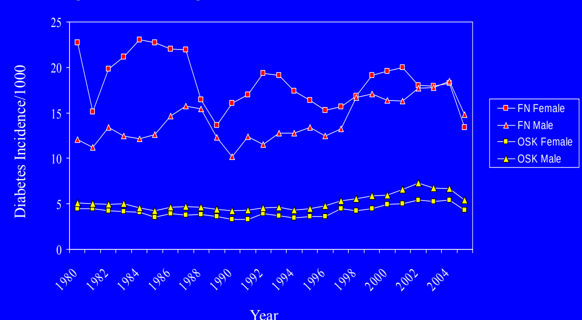

Interaction between Ethnicity & BMI
% GDM
30
25
20
15
10
5
0
26.3
4.7
3.1
4.9
OSK
FN
BMI < 27
BMI ≥ 27

GDM and FN Ethnicity - summary

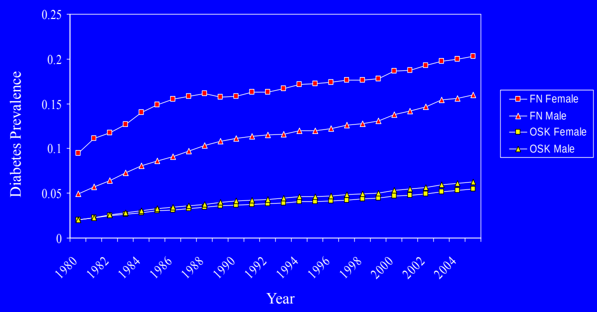
- FN women have significantly higher GDM rates than OSK women
- Higher GDM rates apparent regardless of number of GDM risk factors
- FN ethnicity is an independent predictor for GDM in an interaction with pre-pregnancy overweight/obesity

Recent work…differences in T2DM rates by sex among FN

Age Standardized Diabetes Incidence by Ethnicity and Sex - Saskatchewan



Age Standardized Diabetes Prevalence by Ethnicity and Sex - Saskatchewan



GDM and the Risk for T2DM

- Summary
  - * FN ethnicity is an independent predictor for GDM in an interaction with pre-pregnancy overweight/obesity
  - * High rates of overweigh/obesity & GDM appeared before the significant emergence of T2DM in remote FN communities
  - * Increasing HBW rates have paralleled the appearance of GDM in northern Saskatchewan
  - * HBW is a significant risk factor for T2DM among FN
  - * T2DM incidence and prevalence are substantially higher among FN women than men

GDM and the Risk for T2DM

- Conclusions
  - * Systematic series of population studies in Saskatchewan are consistent with both an intra- and inter-generational impact of GDM in the epidemic of T2DM among FN people
  - * Overall and relative contribution of these processes to the T2DM epidemic remain to be determined

A Vicious Cycle: Investigating the Impact of Gestational Diabetes on Saskatchewan's Epidemic of Type 2 Diabetes Using Dynamic Modeling

Nathaniel Osgood

(Joint work with Roland Dyck, Winfried Grassmann)

Department of Computer Science

Associate, Community Health & Epidemiology

University of Saskatchewan

Talk Outline

- **Our research questions & approach**
- **The GDM/T2DM Model**
  - **Structure**
  - **Parameterization**
  - **Calibration**
  - **Sensitivity analysis**
- **Findings**
- **Conclusions**

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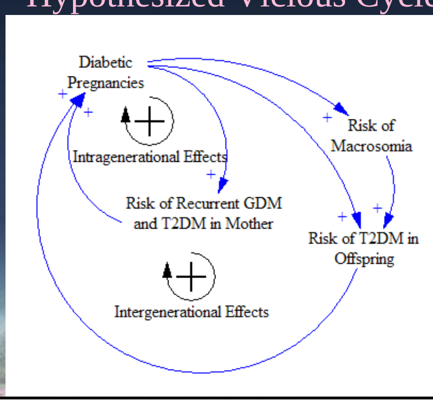
Hypothesized Vicious Cycle(s)



Research Questions

- Is the hypothesized intergenerational driver consistent with the historic growth in obesity, GDM & T2DM?
- How much of the rise of T2DM might be due to GDM?
- How does the magnitude of the impact vary by ethnic & sex group?
- How much of the impact of GDM is mediated via intra- vs. inter-generational effects?

Why GDM Contribution to T2DM is Complex

- Diverse pathways
  - Intergenerational
    - via Macrosomia
    - via Overweight/Obesity
  - Intragenerational
- Diverse mediators & moderators
  - Birth/Fertility rates
  - Trends in overweight incidence

Simulation Models as Dynamic Hypotheses

- Explaining drivers for trends or intervention impact requires understanding of epidemiological processes underlying observables
- Model represents the causal interaction of diverse factors often studied in isolation
- A simulation model operationally captures a hypothesis for "how the system works"
- Model parameters specify detailed assumptions for particular epidemiological contexts

Mathematical Models: Some Uses

- Make explicit mental models of causality, for discussion and collective refinement
- Assist in management of complex situations
  - Help make sense of interaction of diverse information, processes
  - Serve as "What if" tool for identifying desirable policies
    - Cost-effective/High-leverage/Robust
  - Prioritizing research/data collection
  - Identifying inconsistencies between dynamic hypotheses and observables
- Communication (e.g. "learning labs")

Talk Outline

✓ Our research questions & approach
- The GDM/T2DM Model
  - Structure
  - Parameterization
  - Calibration
  - Sensitivity analysis
- Findings
- Conclusions

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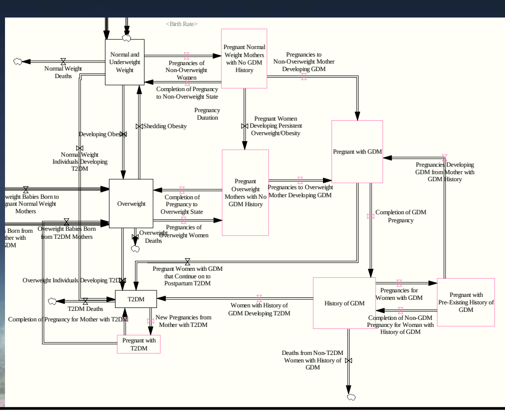
Overall GDM Model Structure



Model Scope

- Health status
  - Weight change
  - Development of T2DM
  - Women
    - Pregnancy
    - Development of GDM
    - Recurrence of GDM
    - Development of T2DM from GDM
- Changes in observed death rates
- Demographics
  - Births
  - Deaths
  - Migration
  - Bill C-31 Status Reclassification
- Multi-decade timeframe
- Saskatchewan population

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Additional GDM Model Characteristics

- Stratification
  - Age (5 year age categories through age 80, 80+)
  - Sex
  - Ethnicity: First Nations (“RI”) & Non-First Nations (“OSK”)
  - *In utero* exposure
  - Normoglycemic population: Overweight
  - Births: Macrosomia
- Time horizon (this talk): 1956-2006
- Time step 3 months

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Talk Outline

✓ Our research questions & approach
- The GDM/T2DM Model
  - ✓ Structure
  - Parameterization
  - Calibration
  - Sensitivity analysis
- Findings
- Conclusions

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Model Parameter Estimation

- Direct estimation
  - Primary clinical & survey data, Saskatchewan Health administrative databases, secondary literature
- Calibration
  - Less easily recognizable parameters
  - Model-structure specific parameters

Saskatchewan Health Administrative Diabetes Data (1980-2005)

- Use of validated algorithm for identifying T2DM cases
  - Sample count ~ 108,000
- Used for model
  - Incident cases
  - Prevalent cases
  - Deaths

Data Sources: Demographics

- Births (1956-2006) & (age-specific) fertility rates
  - OSK: Sask Vital Stats
  - RI: Health Canada (Vital Stats of the RI Population of SK)
- Deaths & Death rates (1956-2006)
  - OSK: Sask Vital Stats
  - RI: Sask Vital Stats, Health Canada (Vital Stats of the RI Population of SK)
- Initial(1956) breakdown
  - RI: INAC
  - OSK: Sask Vital Statistics
- Bill C-31 effects
  - (Vital Stats of the RI Population of SK)
  - Clatworthy/Services Canada
- Migration (1956-2006)
  - OSK: Sask Vital Stats
  - RI: Health Canada (Vital Stats of the RI Population of SK)

Data Sources 2: Weight Change & Pregnancy Related Risks

- Weight gain during pregnancy
  - Gunderson, Abrams et al. 2000
- Birth weightlink with maternal status: Primary data collected for (Dyck, Klomp et al. 2002)
- Obesity risk
  - RI: Bruner, Chad, Dyck
  - Reeder, CCHS
- GDM Risks
  - Initial
    - Preliminary data collected for (Dyck, Klomp et al. 2002)
  - Recurrence
    - Kim, Berger et al. 2007

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Data Sources 3: T2DM Risks

- Immediately following pregnancy
  - Kim et al. 2007
- Following History of GDM
  - *Buchanan, Xiang et al. 2007;*
  - *Lee, Hiscock et al. 2007*
- No history
  - Age, Sex, Ethnicity Specific: Administrative Data
  - Hazard Rate Ratio of
    - OW/OB
      - » Field et. al 2007
    - In Utero Exposure
      - » Franks et al 2007

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Talk Outline

- ✓Our research questions & approach
- The GDM/T2DM Model
  - ✓Structure
  - ✓Parameterization
  - Calibration
  - Sensitivity analysis
- Findings
- Conclusions

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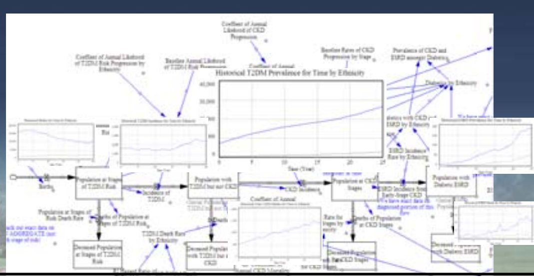
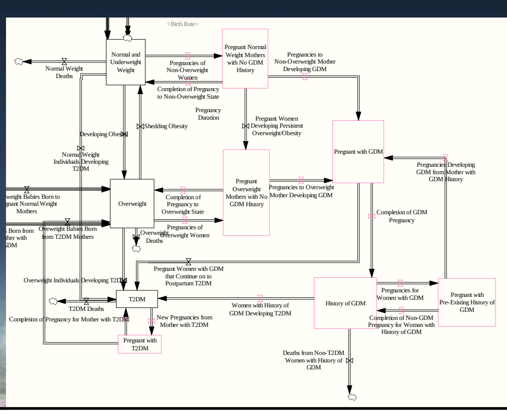
Calibration: An Analytic Triangulation Approach

- Formulate initial model as dynamic hypotheses
- Parameterize models from local data (where possible) & secondary literature
- Calibrate remaining parameters to simultaneously best match all known historic data

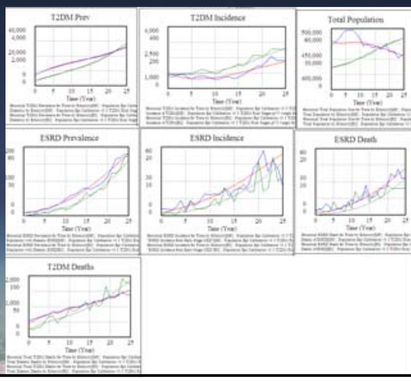
Example of Calibration points from our T2DM/ESRD Work



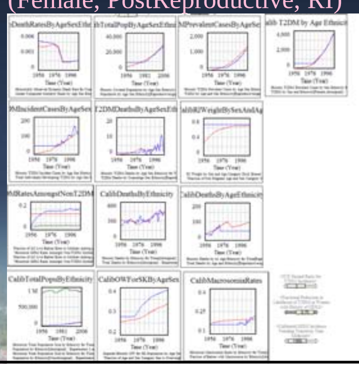
Example Calibration Constraints



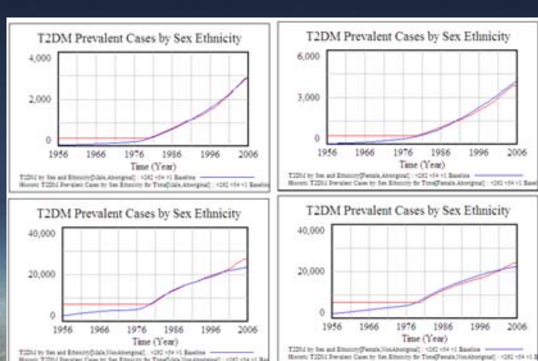
Calibration Matches Many Data Sources



An Example of Some Calibration Matches (Female, PostReproductive, RI)



Calibration Results



Incorporating Calibration Results

- Compare quality of calibrated models
  - Use cross-validation to test model predictions
  - Strongly question models lacking consistency with historic data or predictive ability
- Use variance & sensitivity in calibrated values to prioritize data collection
- Use models with closest calibrations as "best guesses" concerning
  - Drivers for observable epidemiologic trends
  - Underlying epidemiology of infection

Calibration Against Time Series

- T2DM Incident cases (Age/Sex/Ethnicity)
- T2DM Prevalent cases (Age/Sex/Ethnicity, Sex/Ethnicity)
- T2DM Deaths
- GDM rates by Ethnicity
- Total population size
  - By Ethnicity
  - By Age/Sex/Ethnicity
- Historic Deaths
  - Ethnicity
  - Age/Ethnicity
  - Age/Sex/Ethnicity
- Macrosomia levels (Ethnicity)
- Weight
  - RI: (Age/Sex)
  - All: (Age)

Calibration Against Time Series

- T2DM Incident cases (Age/Sex/Ethnicity)
- T2DM Prevalent cases
- T2DM Deaths
- GDM rates by Ethnicity
- Total population size
  - By Ethnicity
  - By Age/Sex/Ethnicity
- Overweight rates by
  - Ethnicity/Sex (General pop)
  - Sex (overall)
- Historic Deaths
  - Ethnicity
  - Age/Ethnicity
  - Age/Sex/Ethnicity
- Macrosomia levels (by Ethnicity)

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Calibration Findings

- The model appears to calibrate adequately against the time series
- Multiple calibrations appear to yield consistent picture
- Calibration is best when using estimate of rate of diabetogenesis amongst GDM survivors on low side of empirical observations *(risk of underestimation bias)*
- Cross calibration: The model reproduces the trends in other time series not used in parameterization & calibration

Talk Outline

✓Our research questions & approach
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  - Calibration
  - ✓Sensitivity analysis
- Findings
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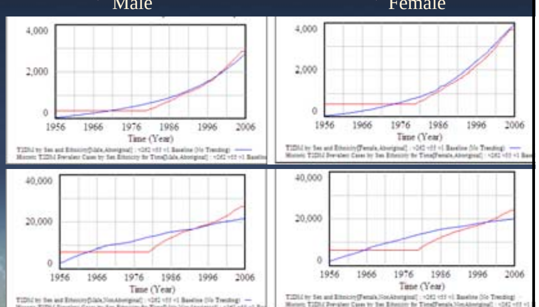
Structural Sensitivity Analysis: Trending vs No Trending (T2DM Prevalent Cases)

Male Female

RI

OSK



Talk Outline

- ✓ Our research questions & approach
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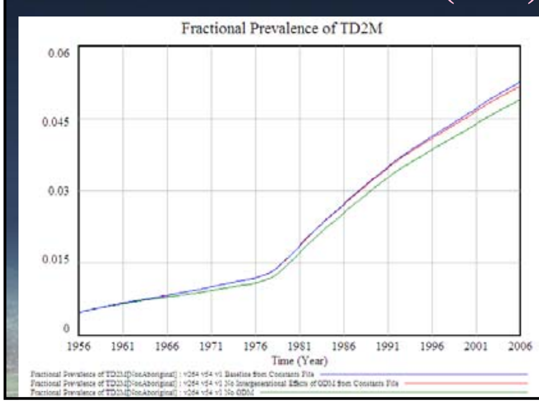
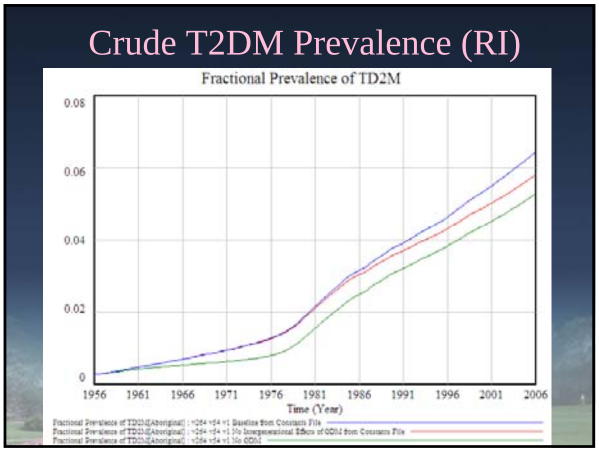
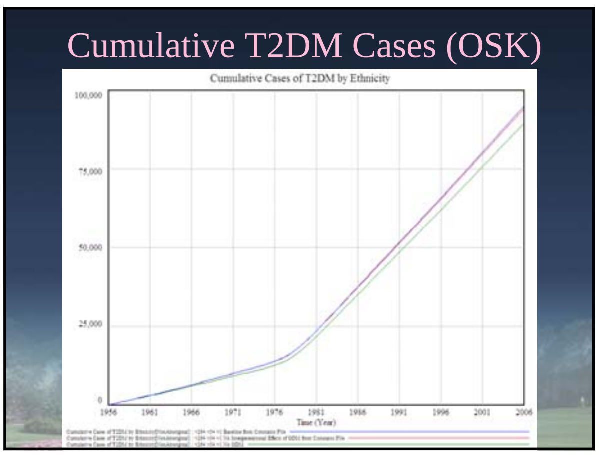
Scenarios Depicted Here

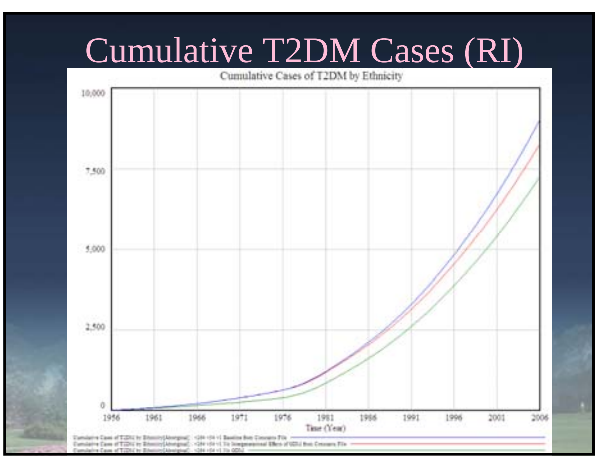
- **Baseline:** Standard calibrated model
- **No intergenerational effect:** No elevation in risk of offspring T2DM from mother's GDM
- **No intra or inter-generational effect:** No effects of Gestational Diabetes

Crude T2DM Prevalence (OSK)




Crude T2DM Prevalence (RI)
Fractional Prevalence of TD2M
0.08
0.06
0.04
0.02
0
1956 1961 1966 1971 1976 1981 1986 1991 1996 2001 2006
Time (Year)


Cumulative T2DM Cases (OSK)
Cumulative Cases of T2DM by Ethnicity
100,000
75,000
50,000
25,000
0
1956 1961 1966 1971 1976 1981 1986 1991 1996 2001 2006
Time (Year)


Cumulative T2DM Cases (RI)
Cumulative Cases of T2DM by Ethnicity
10,000
7,500
5,000
2,500
0
1956 1961 1966 1971 1976 1981 1986 1991 1996 2001 2006
Time (Year)

Inter- vs. Intra-Generational Effects

- Inter-generational effects are significant but
  - More distal (a generation down the road)
  - Occur more in a higher birth rate context (development & recurrence of GDM)
  - Are masked by high numbers of other births
  - These impacts grow significantly over time
- Intra-generational impacts are also pronounced and short-term

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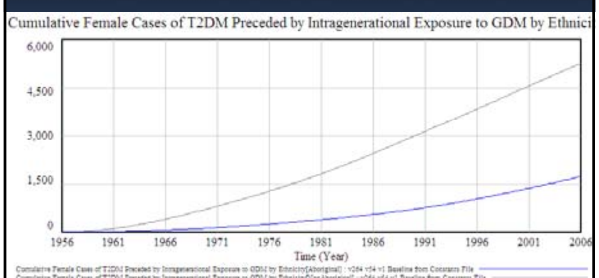
Intragenerational Exposure
Cumulative RI T2DM Cases Preceded by GDM



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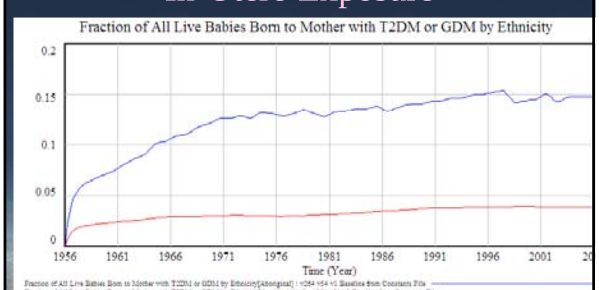
Intergenerational Exposure: In-Utero Exposure



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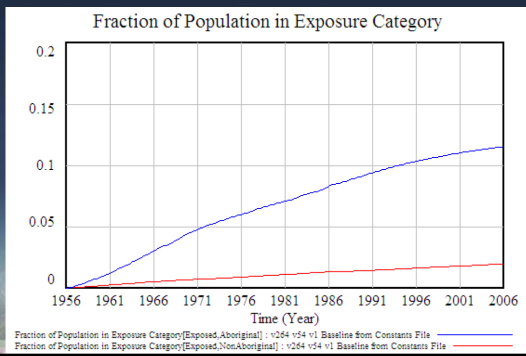
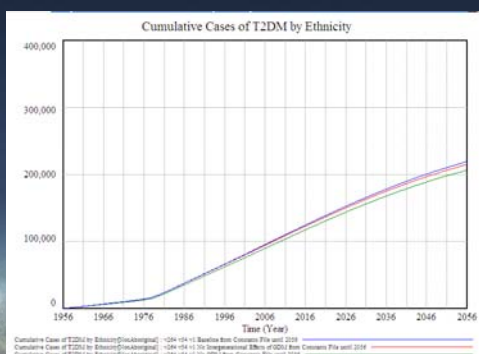
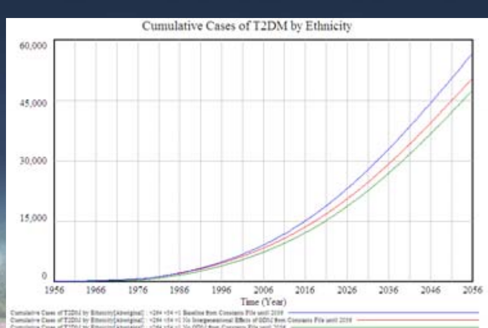
Intergenerational Exposure: Fraction of Populations with Exposure



Longer-Term Effects: OSK



Longer-Term Effects: RI



Findings Summary

- GDM could be contributing substantially to growing T2DM prevalence
  - Effects are appear much larger amongst Aboriginal peoples
  - The effects of GDM on T2DM are growing
- Glycemic control in women of childbearing age has disproportionate effect on future health
  - Both intragenerational & intergenerational effects are large
- Assumptions regarding rate of diabetogenesis in those with history of GDM has a large impact on T2DM rates
  - Estimates shown here may well be *underestimates*

Talk Outline

✓ Our research questions & approach
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  - ✓ Parameterization
  - Calibration
  - ✓ Sensitivity analysis

✓ Findings
- Conclusions

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Closing Thoughts

- GDM is not only important but prevalent, readily identifiable, preventable and treatable
- The findings here have worldwide implications
- Rate of diabetogenesis in those with history of GDM across SK subpopulation is a priority for investigation

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Acknowledgements
• NSERC Discovery Grant Funding
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• Jing Bai
• Amy (Yu) Gao
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Administrative Data: A Valuable Tool for Modeling Health Service Utilization and Outcomes for Chronic Disease

Lisa M. Lix, PhD P.Stat.
University of Saskatchewan

Workshop on Dynamic Modeling for Health Policy

July 24, 2009

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Outline

- Background
- Administrative data and data repositories
- Strengths and limitations
- Identifying obesity cases
- Obesity-related chronic disease
  - Identifying disease cases
  - Challenges
- Data linkage
- Further research opportunities
- Conclusions

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Background

- Population-based administrative data have multiple uses in the study of obesity and obesity-related chronic diseases
  - Monitor demographic, socioeconomic, and temporal variations in prevalence and incidence
  - Detect geographic clusters
  - Compare health service use and costs for cases and controls
  - Investigate quality and/or processes of care for cases and controls

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A Definition of Administrative Data

- Data collected for purposes of health system monitoring, financial management and provider remuneration
- Not originally intended for research

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Administrative Data Repositories

- Core components of a typical repository
  - Registry – population identification, demographic characteristics
  - Hospital database – abstracts (summaries) of hospital events, including diagnoses and procedures
  - Physician database – billing claims used for fee-for-service remuneration – include service information and diagnosis(es)
  - Vital statistics database – deaths, births

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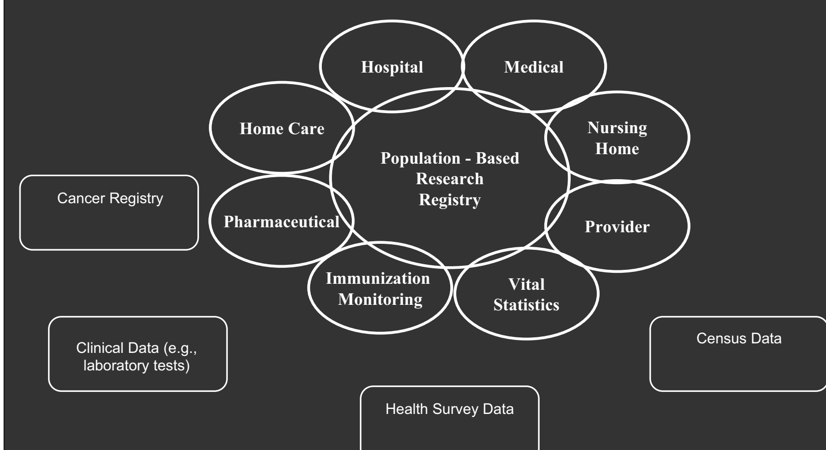
Structure of an Administrative Data Repository



Based on the figure by Roos, Menec, & Currie (2004)

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Strengths of Administrative Data

- Population-based
- Longitudinal histories can be constructed
- Relatively inexpensive compared to primary data
- Address multiple policy-relevant questions
  - Health disparities
  - Equity of access
  - Quality of care
  - Processes and outcomes of care

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Limitations of Administrative Data

- Do not contain information about body composition (e.g., height, weight) or risk factors (physical activity; food consumption)
- Variations in data quality over time, across geographic areas, and across databases
- Changes in the way data are captured/recorded
  - WHO's International Classification of Diseases: Change from ICD-9 to ICD-10

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Identifying Obesity Cases: Diagnoses

- ICD-9-CM
  - 278.00: Obesity, unspecified
  - 278.01: Morbid obesity
  - V85: Body Mass Index (BMI) , Kilograms per meters squared
    - V85.4x: Body Mass Index 40 and over, adult
- ICD-10-CA
  - E66.0: Obesity due to excess calories
  - E66.1: Drug-induced obesity
  - E66.2: Extreme obesity with alveolar hypoventilation
  - E66.8: Other obesity
  - E66.9: Obesity, unspecified

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Validity of Obesity Diagnoses

- Wood et al. (2009) – Journal of Pediatrics
  - US study comparing BMI calculated from medical record with ICD-9-CM obesity diagnoses in hospital data
  - Children/youth aged 2-20 years
  - Under-reporting of obesity diagnoses in hospital data:
    - sensitivity: 8.0%
    - specificity: 99.8%

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Identifying Obesity Cases: Procedures

- ICD-9-CM
  - 44.38: Laparoscopic gastroenterostomy
  - 44.39: Other gastroenterostomy
  - 44.95: Laparoscopic gastric restrictive procedure
- ICD-10-CA: Canadian Classification of Interventions (CCI)
  - 1.NF.78^^: gastric banding

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Surgical Procedures

TABLE 1. Bariatric surgery in selected provinces in Canada*, 2003–04

	NUMBER OF PROCEDURES	MEAN AGE (YEARS)	% FEMALE	MEAN LOS (DAYS)
British Columbia	109	41	88	3.0
Alberta	224	37	91	5.5
Saskatchewan	41	39	83	10.3
Ontario	303	40	84	4.9
Nova Scotia	47	39	85	6.4
Total	724	39	87	5.2

*Excludes Manitoba and Quebec because of differences in data collection methodology and provinces/territories where fewer than five procedures were performed annually.

Source: Discharge Abstract Database, CIHI.

Source: Jokovic A, Frood J, Leeb K. Bariatric surgery in Canada. *Healthcare Policy* 2006;1:64-70.

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Obesity-Related Chronic Diseases

- Hypertension
- Diabetes
- Coronary artery disease
- Other cardiovascular disease
- Hypercholesterolemia
- Osteoarthritis
- Stroke
- Cancers: colon, breast, endometrial, kidney, esophageal

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Identifying Disease Cases

- Constructing a case definition
- Validating a case definition
- Comparing case definitions over time and across jurisdictions

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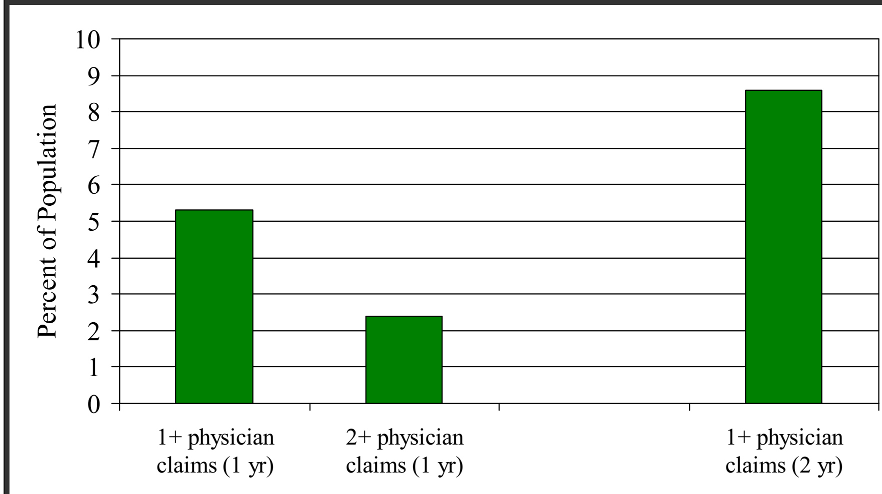
Constructing a Case Definition

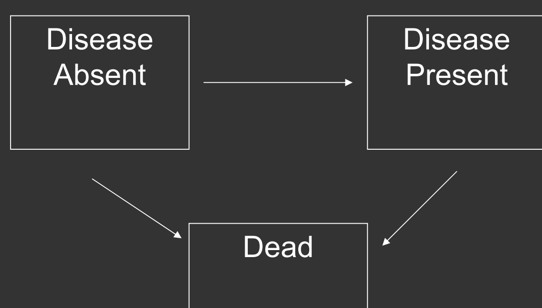
- Elements
  - Type of data source
  - Number of years of data
  - Diagnosis and/or prescription codes
  - Number of contacts with health system

  - Accruing cases over time

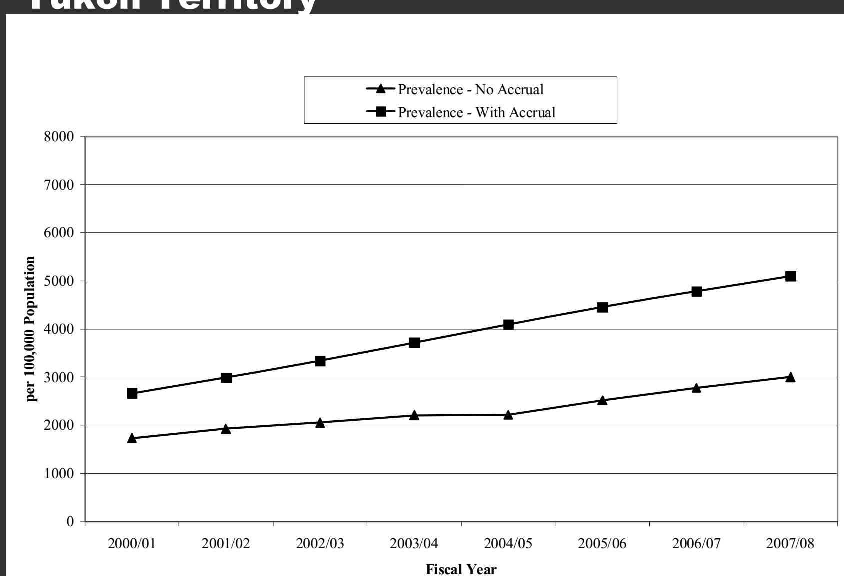
Osteoarthritis, Crude Prevalence Estimates, Manitoba, 2004/05 – 2005/06



Assumption Underlying Case Accrual



Diabetes, Illustration of Case Accrual, Yukon Territory



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Validating a Case Definition

- Gold Standard Exists
  - Estimate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV)
- Gold Standard Does Not Exist
  - Biased gold standard
  - Capture-recapture methods

Estimating Sensitivity, Specificity, PPV, NPV

Gold Standard

Admin Data		Has Disease	Does Not Have Disease
	Has Disease	A	B
	Does Not Have Disease	C	D

Sensitivity = A/(A+C)*100

Specificity = D/(B+D)*100

PPV = A/(A+B)*100

NPV = C/(C+D)*100

Validating Osteoporosis Case Definitions, Manitoba Bone Mineral Density Tests as the Gold Standard

# years	Algorithm	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	YI
1	1+ P	69.4	92.7	91.7	72.2	0.62
	2+ P	34.1	99.1	97.8	56.3	0.33
	1+ Rx	78.5	90.1	90.3	78.2	0.69
	1+ H or 1+ P	69.4	92.7	91.7	72.2	0.62
	1+ H or 2+ P	34.1	99.1	97.8	56.3	0.33
	1+ H or 1+ P or 1+ Rx	89.4	86.1	88.3	87.5	0.76
	1+ H or 2+ P or 2+ Rx	77.7	91.8	91.7	77.9	0.70
2	1+ P	74.0	90.0	89.6	74.8	0.64
	2+ P	43.9	96.9	94.3	59.7	0.41
	1+ Rx	82.2	88.5	89.3	81.0	0.71
	1+ H or 1+ P	74.0	90.0	89.6	74.8	0.64
	1+ H or 2+ P	43.9	96.9	94.3	59.7	0.41
	1+ H or 1+ P or 1+ Rx	92.0	83.1	86.4	89.9	0.75
	1+ H or 2+ P or 2+ Rx	83.4	89.5	90.3	82.2	0.73

Note: P = physician billing claims; H = hospital separation abstracts; Rx = prescription drug data; YI = Youden's index

Gold Standard Does Not Exist

- Biased gold standard
  - Adjust the estimates of sensitivity, specificity, PPV, NPV based on the estimated amount of bias in the gold standard.
  - Average the estimates of sensitivity, specificity, PPV, NPV across several biased gold standards to arrive at a 'true" estimate.

Validating Osteoarthritis Case Definitions Using the Canadian Community Health Survey, Cycle 3.1

# Years		Algorithm	Sens. (%)	Spec. (%)	PPV (%)	NPV (%)
1	1	1+ P	27.5	96.8	48.9	92.4
	2	2+ P	16.4	98.9	61.6	91.5
	3	1+ H or 2+ P	16.8	98.8	60.6	91.5
	4	1+ H or 2+ P or (1 P & 2+ Rx)	22.9	98.0	56.3	92.1
2	5	1+ P	35.4	94.8	42.9	93.0
	6	2+ P	23.8	97.9	55.4	92.1
	7	1+ H or 2+ P	23.9	97.8	54.3	92.1
	8	1+ H or 2+ P or (1 P & 2+ Rx)	31.2	96.6	50.0	92.7

Note: P = physician billing claims; H = hospital separation abstracts; Rx = prescription drug data

Validating Hypertension Case Definitions Using the Canadian Community Health Survey, Cycle 3.1

# Years		Algorithm	Sens. (%)	Spec. (%)	PPV (%)	NPV (%)
1	1	1+P	56.7	96.2	81.8	88.2
	2	2+P	40.9	98.6	89.6	84.9
	3	1+H or 1+ P	57.8	96.2	81.7	88.4
	4	1+ H or 2+ P	42.5	98.5	89.3	85.2
	5	1+ H or 1+ P or 1+ Rx	78.5	92.4	75.5	93.5
2	6	1+P	68.6	93.0	74.5	90.9
	7	2+P	55.1	97.0	84.4	87.9
	8	1+H or 1+ P	69.9	92.8	74.1	91.2
	9	1+ H or 2+ P	56.7	96.7	83.5	88.2
	10	1+ H or 1+ P or 1+ Rx	81.4	89.1	68.9	94.1

Note: P = physician billing claims; H = hospital separation abstracts; Rx = prescription drug data

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Gold Standard Does Not Exist

- Capture-recapture methods
  - Regression models or non-parametric estimation methods used to estimate the size of the population by estimating the number of cases captured in individual data sources and in the overlap of two or more data sources
  - Assumptions:
    - High-quality data linkage
    - Homogeneity of capture across data sources
    - Independence of data sources

Osteoporosis Prevalence Estimates, Capture-Recapture Models for Physician and Prescription Data, Manitoba

	1999/00	2000/01	2001/02	2002/03	2003/04
			Parametric Method		
N	14765	17599	20018	22799	24727
(95% CI)	(14608, 14923)	(17408, 17785)	(19821, 20224)	(22580, 23007)	(24506, 24962)
Capture Rate (%)	71	72	74	75	76
			Non-Parametric Method		
N	14957	17576	19908	22485	24516
(95% CI)	(14665, 15250)	(17273, 17878)	(19598, 20218)	(22177, 22793)	(24199, 24833)
Capture Rate (%)	71	72	74	76	77

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Data Linkage: Administrative and Survey Data

- Behavioral risk factors
  - Physical activity
  - Food consumption
- Socio-demographic and environmental determinants
- Quality of life

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Data Linkage: Survey and Administrative Data

- Potential barriers
  - Lack of a unique personal identifier
  - Data privacy legislation
  - Permission for linkage
- Survey availability: one time versus ongoing collection

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Further Research Opportunities

- New data fields in administrative data
  - Height, weight
- Data quality and completeness
  - Develop methods
  - Feedback to data custodians
  - Training in data collection techniques
- Expand data repositories
  - Public health services
    - Contacts with dieticians, psychologists
  - Physical environment: Availability of green spaces, crime
- New classification systems
  - Symptoms, not just diagnoses

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Conclusions

- Administrative data have limited value for estimating prevalence/incidence of obesity
- Obesity-related surgical procedures are few in number and may not be consistently captured in all jurisdictions
- Administrative data have significant value for population-based research about obesity-related chronic diseases

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Conclusions

- The use of administrative data in obesity-related chronic disease research requires use of a systematic methodology to construct case definitions.
- Data quality issues create significant inefficiencies in the use of administrative data for research.
- Existing data repositories require expansion to include new and data fields and data sets that will help to address questions of current interest in the policy environment.

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Conclusions

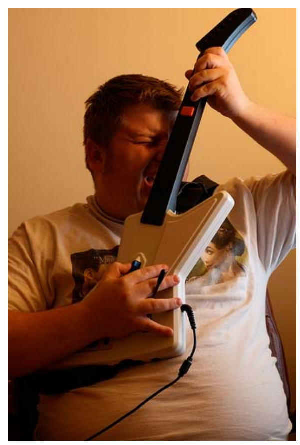
- State-of-the art developments in the use of administrative data and data repositories for obesity research require a team approach: clinicians, epidemiologists, statisticians, computer scientists, health services researchers, public health professionals, policy analysts.

Integrating Monitoring into Everyday Activities

Regan Mandryk
Kevin Stanley
University of Saskatchewan

Introduction

- Obesity and diabetes are a significant problem in North America
  - In part due to technical advances in entertainment and food science
- Discuss new technologies and techniques for measuring and combating these issues in a non-clinical context



Presentation

Present

Using Persuasive Technology to Raise Awareness of Caloric Balance

Gemini: Persistent asynchronous exergaming

Future

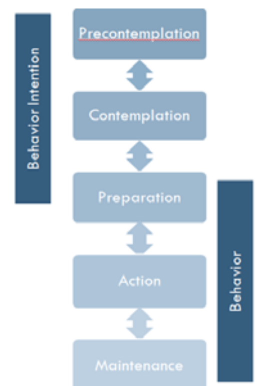
Photo Food Diary

Data Acquisition

Using Persuasive Technology to Raise Awareness of Caloric Balance

Debby Bates, Honours Thesis

Motivation

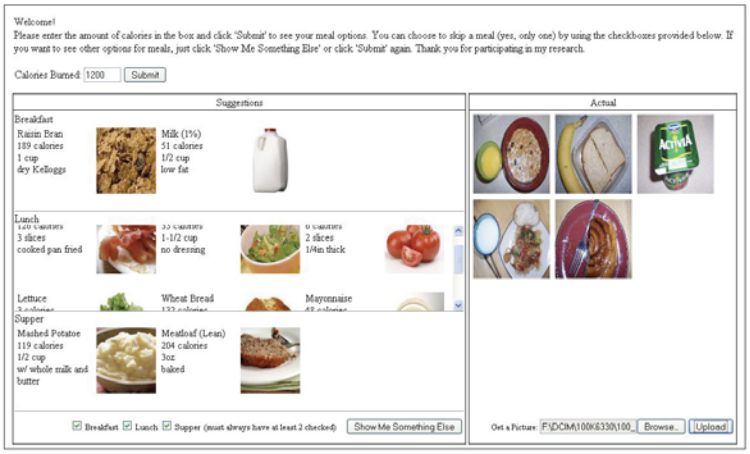


- Raising awareness of
  - Caloric consumption
  - Caloric output
  - Resulting caloric balance
- Use persuasive technology to show the importance of this balance
- Used trantheoretical model of behavioral change

Preliminary Experiment

- Required Equipment
  - Bodymedia Sensewear armband
  - Computer with armband software and Firefox web browser
  - Camera phone or digital camera

Interface



Data and Results

- Entry Questionnaire
  - Stages of change
  - Demographics
  - Multiple choice calorie
  - Healthiness scale
- Exit Questionnaire
  - Stages of change
  - Multiple choice calorie
  - Healthiness scale
  - Open ended

How many calories do the follow foods have? (Circle one)

	A	B	C	D
1 cup plain low fat yogurt	150	200	80	110
1 boneless skinless chicken breast	300	200	280	250
½ cup cooked long grain brown rice	120	100	150	70
½ cup 1% milk	50	30	75	100
1 slice whole wheat bread	50	70	80	100
1 tbsp smooth peanut butter	40	100	50	95
1 cup sliced strawberries	100	30	70	50

I frequently eat fruits and vegetables.
Strongly Agree **Strongly Disagree**
1 2 3 4 5

I need to participate in more physical activity.
Strongly Agree **Strongly Disagree**
1 2 3 4 5

Quotes

Will you pay more attention to your activity level from participating in this experiment?

"Yes. I do not exercise much, but apparently drinking beer counts?"

"Yes. I want to be more active."

"Yes. I also noticed that I need to be physically active daily in order to burn enough calories to lose weight."

How did you feel about taking pictures of what you were eating?

" … it did help me to not eat seconds at supper because I didn't want to take another picture."

"You are less likely to eat a chocolate bar for lunch if you have to record it in some manner."

" It was a good way to make me aware and think about what I was eating"

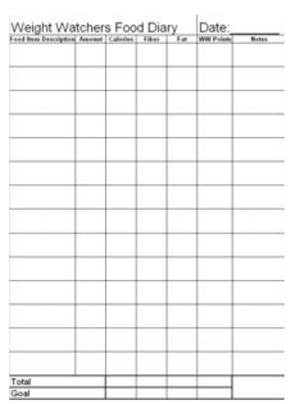
Future Directions

- Run controlled experiment with large sample
  - Knowledge of caloric input, caloric output, an caloric balance
  - Behavioral change
  - Persuasiveness of technological intervention
- Include tools for scaffolding from pre-contemplation and contemplation to preparation and action

Photo Food Diary

Motivation

- Give people technological tools to help them make good choices when they still have the opportunity to change their behavior
  - Current food diary solutions happen after the fact when change is impossible and regret can be large
- Make it easy on users to log and analyze their eating patterns



Background

- L. Zepeda and D. Deal (2008). **Think before you eat: photographic food diaries as intervention tools to change dietary decision making and attitudes**. International Journal of Consumer Studies, Volume 32 Issue 6, Pages 692 - 698.

Approach

- Why stop at images?
- Convergence in devices provides other sensors
  - Where?
  - When?
  - With whom?
- Useful for tracking consumption and also for review

Two-part application

Mobile Input

- Sensors
  - Camera
  - Time
  - GPS Location
    - Tagged
  - Social Network

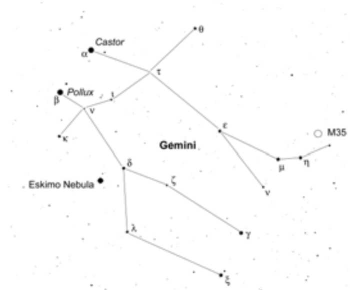
Review with Infoviz

- Single User
  - Accountability
  - Data Analysis
- Social Network Site
  - Single User Benefits
  - Social Accountability
- Public Site
  - Social Network Site
  - Public Accountability

Exergames

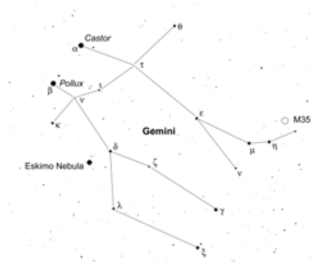
Gemini

- Digital Twin
- Activities in the real world impact the virtual
- Sensors and persistence
  - More immersive MMO
  - Blogging by existing in Second Life
  - As in game rewards for out of game activity in an exercise game



The Team

- Colleagues
  - Regan Mandryk
  - David Pinelle
- Graduate Students
  - Mohammad Hashemian
  - Ian Livingston
- Undergraduate Developers
  - Alan Bandurka
  - Rob Kapiszka
  - David McDine



Traditional Exercise

Gemini

UbiFit Garden

Fish 'n Steps

Neat-o-games

Jogging over a Distance

Kukini

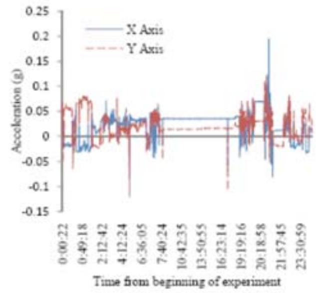
Gemini Version 1

The Game

- Modification of chess
- Moves occur in real time
  - No turn sequence
- Pieces have statistics
  - Attack
  - Defense
  - Speed
- Chance that piece capture will fail based on ratio of attack and defense

Mappings

- Collected low frequency activity data every 10 s
  - Context
  - Activity
- Higher frequency 21Hz data every 10 minutes
  - Activity vigor



	Sustained motion	Motion outdoors	Motion indoors
Low vigor	Pawn speed	Pawn attack	Pawn defense
High vigor	Major speed	Major attack	Major defense

Experiment

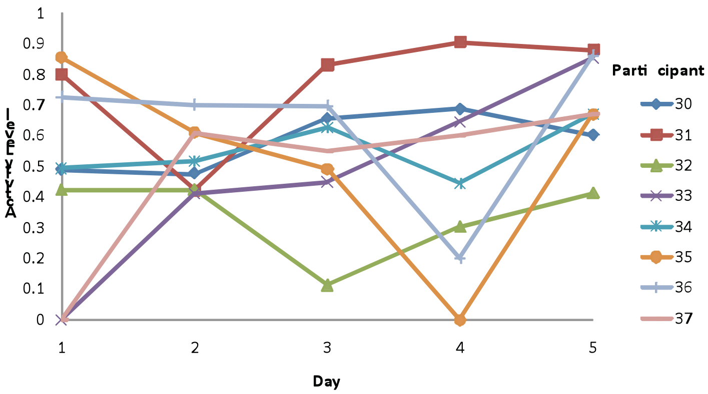
- Participants wore their motes from 10 AM to 3 PM every day
- 2 on 2 RT Chess tournament from 9-10 AM
  - Round robin
  - Best overall record declared winner for the day
- Mapping knowledge changed through experiment
  - Had little effect in game
  - Had some effect on how participants felt about the game

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Equal stats	Different preset stats	Individual stats, *unknown* mappings		Individual stats, *known* mappings	

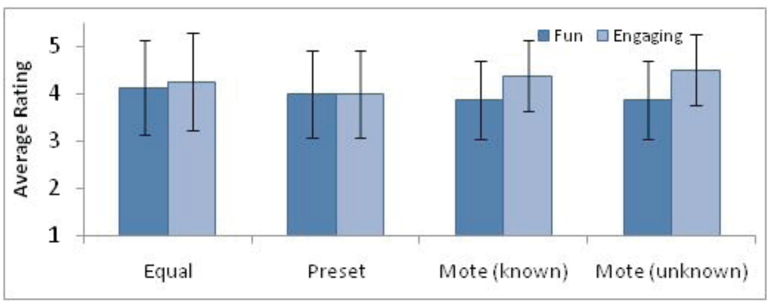
Results

- The Good
  - *"In an average day when I come across stairs and an elevator, I take the elevator when it's available and stairs otherwise. The mote made me actively take the stairs all the time."*
- The Bad
  - *"The first day I had average activity, and the next day thought I had above average, but my stats kept getting lower."*
- The Ugly
  - *"I felt that when it was more balanced, in terms of objective stats, the game was more interesting and more varied in terms of the strategies that either team employed."*

Results



Results

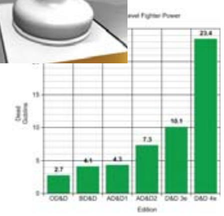


Recommendations

- **Game Design**
  - **Context Sensing Should Not Weaken the Game**
- **Sensing and Mapping**
  - **Small Changes Matter**
  - **Non-Linear Scaling**
  - **Mapping Depth**
- **User Experience**
  - **Feedback**
  - **Intrusiveness**

Game Design

- Users have preferred play styles
  - Life may not match it
- No attachment to a pawn or rook
  - Persistent avatar
- Persistence in a 7 second game?
  - Add concept of cumulative gains



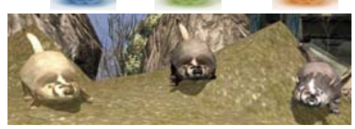
Gemini Version 2

Platform

- Neverwinter Nights 2
  - Custom (small) persistent world
  - Extensible through scripting
- Provides modern game
  - Look
  - Interface
  - Balance
- Difficult to build outside of the D&D canon

Platform

Game Design



- Separate exercise statistics from primary game play style
- Ownership but not interfering with character
  - Changes appearance and size based on exercise
- Built in support for persistence
  - Level balancing built in

Sensor

- Identical hardware
- Opportunistic sinking
- Removed vigor
- Added social
- Split mappings by game
- Leverage existing level balancing
  - Scale for reality

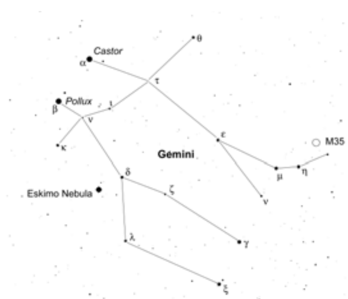
	Activity with Friend	Activity Outdoors	Activity Indoors
PvE	Bard	Barbarian	Monk
PvP	Fire (damage)	Ice (slow)	Purple (weaken)

Gemini Version N

- Continue to advance game play
- Shift focus towards new mobile computing devices
  - Integrate BlueTooth physiological monitors
  - Provide additional blurring between persistent virtual and real world

Conclusions

- It is possible to use in game rewards for out of game activity
- Mappings don't have to be obvious
- Game must be compelling
- Demographics matter



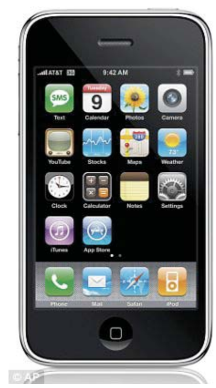
Data Acquisition

Beyond Exercise

- Side effect of persistent gaming
  - Gather a great deal of contextual data
    - Particularly contextual activity data
- How might we leverage this information?
  - Outcomes for individual
  - Modeling data

Context and Data

- Gather data on the context
  - Activity, meal time and size
    - When?
    - Where?
    - With Whom?
    - Under what conditions?
- In the wild
  - Could be in conjunction with medical studies

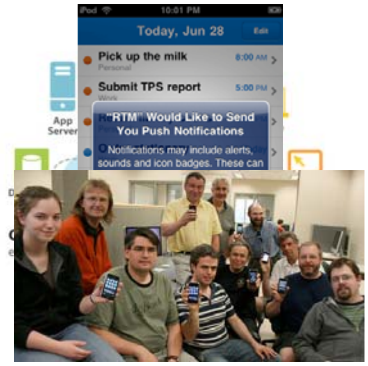


Potential of Convergence

- Sensors on the iPhone
  - Touch interface
  - Camera
  - Proximity
  - GPS
  - Accelerometer
  - Microphone
- Communications
  - Cellular
  - Wifi
  - Bluetooth

Communications

- Automatic data retrieval
  - Time stamped and location anchored
  - Only on Wifi
- Automatic communication with participants
  - Change in study parameters
  - Reminder to get exercise
- Automatic recruiting
  - Uncontrolled studies



Conclusions

- New sensor technologies can change the way that chronic disease is tracked and treated
  - Exergames
  - Auto journaling
  - More sophisticated data acquisition

Thank You

Chronic Disease Systems Modelling Laboratory
SFU SIMON FRASER UNIVERSITY

A system dynamics model of body weight regulation and obesity

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Outline

- Introduction
- Methodology
- Problem Description and Background
- Data
- An endogenous (structural) explanation of weight cycles

Introduction

- Incidence of overweight and obesity is increasing across the world
- Excessive body weight is associated with various health complications: type 2 diabetes, cardiovascular diseases, sleep apnea, certain forms of cancer.
- Factors influencing the regulation of body weight have been under intensive investigation.
- Growing interest has culminated in the growth of simulation models:
  - as a tool to investigate this complex system
  - as a means for evaluating hypotheses concerning the underlying pathology of obesity

Introduction

- Body weight regulation constitutes a suitable area for simulation modeling, considering:
  - feedback complexity of the underlying structure
  - different levels of factors involved (genetic, dietary, life-style, socio-economic)

- Previous applications body weight regulation-obesity (focus on different aspects, using different tools):
  - Abdel-Hamid (2002, 2003), Homer, Milstein, Dietz, *et.al.*, (2006), Oga and Uehara (2003), Flatt (2004), Hall (2006), Chow and Hall (2006), Christakis and Fowler (2007), Christiansen and Sorensen (2008), Goldbeter, (2006).

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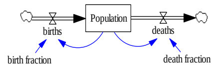
Methodology

- Relative constancy of body weight and composition maintained by homeostatic (feedback) mechanisms
- Time delays, interplay of factors make it difficult to make quantitative predictions of dynamic patterns
- Non-linear feedback structure
- Obesity is a "dynamically complex" problem
- DYNAMIC Problems
  - Things change over time
  - A dynamic problem is one that necessitates continuous monitoring and action ("management"). "Chronic" problems.
  - Internal structure of the "system" as main cause of dynamic behavior~ built environment

➡ SD appropriate for quantitative analysis of chronic problems

Methodology- System Dynamics

- A simulation-based procedure for complex dynamic systems
- Main focus: Internal feedback structure, identifying internal relations causing system behavior
- "Predicting" the ***"dynamic pattern"***, instead of predicting system variables point-by-point
- System represented by stock, flow and auxiliary variables



- Corresponds to a set of difference/differential equation

Steps of System Dynamics methodology

- Problem identification *(A dynamic feedback problem is selected)*
- Model conceptualization *(causal loop diagramming)*
- Model construction *(mathematical, numeric)*
- Simulation & verification testing
- Validation (*Is the model an adequate, acceptable, sufficient representation of the real system with respect to my problem of concern?)*
- Analysis and results *(A series of experiments designed and analyzed to reach results)*
- Implementation

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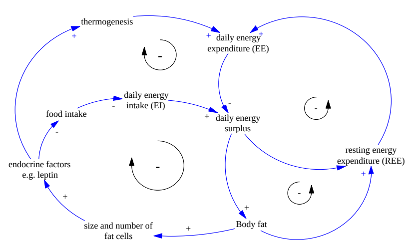
Problem Description and Background

- Most adults maintain a stable body weight and composition, in spite of having substantial deviations in daily food intakes and PA levels
- Energy intake and expenditure tend to remain adjusted
- As long as this is not the case, body composition keeps changing until a particular configuration is reached to satisfy both of these conditions

- Corrective responses-homeostatic mechanisms:
  - Regulating food intake
  - Altering rate of energy expenditure
  - Altering the composition of fuel mix used for energy generation

Problem Description and Background



Problem Definition and Research Objective

- Long-term stability of body weight and composition implies: deviations from energy balance trigger the body's homeostatic mechanisms to adapt to those changes.

- Diet induced changes in energy expenditure help to slightly attenuate the gap between energy intake & expenditure, but does not have power to offset energy imbalances.

- Regulation of food intake seems to be a more important phenomenon to help achieving a steady-state body weight over long periods of time.

- We aim to explore the interactions btw the body composition and food intake regulation.

Problem Definition and Research Objective

- Purpose of this modeling study: To develop a dynamic representation of our body weight regulatory system in normal and obese states
  - To develop a well-validated model which represents the underlying structure of body weight regulation for an individual normal adult subject with a given set of initial conditions
  - This model will be modified to explain the development of obesity and related compensatory changes in the metabolism
  - Another research objective: To simulate the model to examine a common feature called "weight cycling" seen in obese people who try to fight against their excessive fatness

Outline

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Data: Long-term assessment of energy balance and its relation to body composition

- **Investigators:** Dr. Scott Lear, Dr. Diane Finegood
- **Purpose:** To identify how the amount of food we eat daily (caloric intake) and the amount of physical activity (caloric expenditure) relate to changes in body fat, bone and muscle.
  - How day-to-day changes in energy balance affect our weight. We believe that our body will adjust to minor daily changes in 'energy' balance but larger ones will result in changes in weight and body composition.
- **Research Design**: This study recruits 20 participants who will record daily dietary intake and physical activity for a period of 3 months.
  - 10 participants who are interested in losing weight and 10 who are interested in maintaining weight.
  - Participants will undergo weekly assessment of anthropometry, body composition, resting energy expenditure and provide a fasting blood sample.

Outline

- Introduction
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Weight Cycling

- An endogenous (structural) explanation of weight cycles
  - Weight cycling, or "yo-yo dieting", as a common feature
  - Unintended consequences of dieting: Hysteresis effects on body composition
  - Both supportive and counter-arguments
- We think drivers for "natural" weight cycles and today's "yo-yo dieting" and consequent body weight trajectories are different in nature
  - First dynamic behavior mainly driven by "externally" imposed function
  - We cannot observe a similar external data source for the latter case

Weight Cycling

- We see a pattern in the real data, but cannot observe any externally imposed functions to explain this cyclic behavior
- ➡ Endogenous (structural) explanation for weight cycles
  - Without having external data force, peoples weights are oscillating, i.e. problem "structural"
  - Structure: Complex interactions between our physiology, psychology, behavior & social factors
  - Requires an understanding of the underlying structure and its complex interactions
  - Problem is quantitative and dynamic: well suited to computer simulation
- Iteratively develop models of varying size & scope along with the development of hypotheses & supporting evidence

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UNIVERSITY OF SASKATCHEWAN

Orientation Information for the

First Annual Workshop on Dynamic Modelling for Health Policy: Obesity & Obesity Related Chronic Disease

July 22-24, 2009

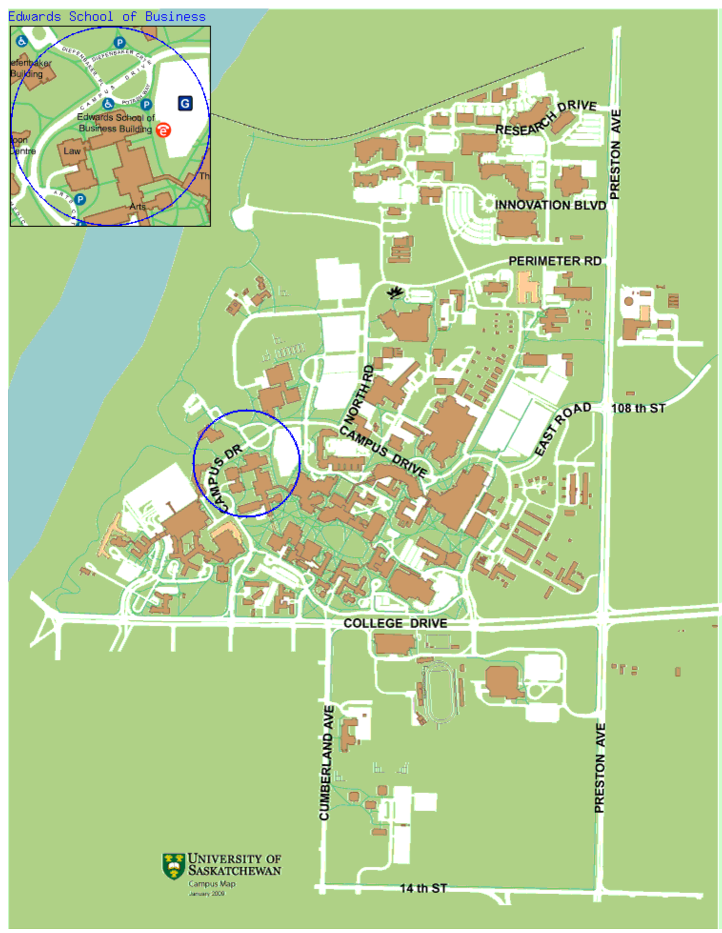
http://www.healthpolicymodellingworkshop.ca

The Lupina Foundation | UNIVERSITY OF SASKATCHEWAN School of Public Health | UNIVERSITY OF SASKATCHEWAN College of Arts and Science

WORKSHOP LOCATION

The workshop will be held on the University of Saskatchewan ("U of S") Campus in the Goodspeed lecture theatre, **Room 18 in the Edwards School of Business ("Commerce") Building** at 25 Campus Dr. The workshop location is indicated in the blue circle to the right. The multimedia-equipped lecture theatre is located just inside & to the left of the lobby entry. ***U of S campus maps will be available upon request from conference volunteers (identifiable by their sporting green lanyards around their necks).***

The room location offers convenient access to a quiet and **comfortable area for phone conversations** (in Atrium just around the corner; **landlines available**), **WiFi, computers for internet access *(a volunteer will be stationed nearby during Health Breaks to log you in)***, drinking fountains and **washrooms (down the corridor just opposite the lecture theatre)**.



ACCOMMODATIONS

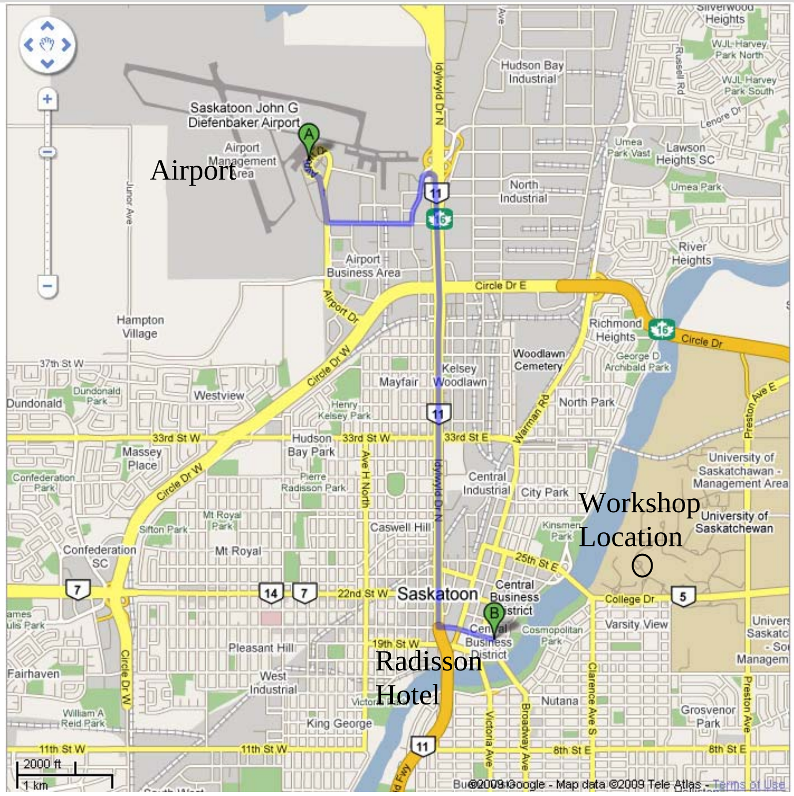
Most out-of-town participants will stay at the Radisson Hotel in downtown Saskatoon, steps from the South Saskatchewan River and the verdant and extensive riverside **Meewasin Valley Trail**, well designed for walking&running, especially following Saskatoon's **exceptionally early summer sunrises** and during the **long summer evenings**. ***Workshop volunteers can provide city & Meewasin Valley Trail maps.***

The hotel is close to a variety of attractions including **River Landing** (park, centre & eatery)**, Farmers Market, Mendel Art Gallery, Delta Bessborough Hotel**.

The Radisson also places participants close to a number of **events** that will take place during or shortly after the workshop:

- **Dragon Boat Festival** (July 24th & 25th). Includes food, entertainment and opportunities to watching colorful boat races. Rotary Park, 9am-10pm. 227-7622.
- **Shakespeare on the Saskatchewan** (Throughout workshop; currently offering performances of "*A Midsummer Night's Dream*" and "*Anthony and Cleopatra*"). Located in tents just behind Mendel Art Gallery (Spadina Cr; 384-7727).
- **Saskatoon Farmer's Market** (July 22nd & 25th) Local specialties. 19th Street and Avenue B. Access via **River Landing** pedestrian bridge. July 25 features a **special Saskatoon Chef's Association sampling of Market products**. 384-6262.
- **Smoke on the Water BBQ Competition.** (July 25th 5pm-11pm & July 26 9:30am-6pm. info@saskbbq.ca)
- **Medieval Feast** July 26 at 5:30pm. At **Elizabethan Village** of Shakespeare on the Saskatchewan, behind Mendel Gallery.

Additional events are listed in the Tourism Saskatoon booklet in workshop materials & at http://planetsmag.com or http://www.tourismsaskatoon.com



Hotel Address & Contact Information:
405 20th Street East
Saskatoon, SK. S7K-6X6
Phone: (306) 665- 3322 Fax: (306) 665-5531
http://www.radisson.com/hotels/sksaskat

Hotel Amenities:
High-Speed Internet
Pool
Fitness Center
Suites
Pets Allowed

Directions to the Hotel from the Airport (see map above):

1. Head southwest on Airport Dr
2. Turn left at 45th St W
3. Turn left at Ave C North
4. Take the ramp onto Idylwyld Dr N E/SK-11

Turn left at 20th St E

The hotel is located within walking distance of the workshop. During appropriate walking weather, a workshop volunteer (identified by green nametag stickers) will be available to walk fitness-oriented participants back from the workshop to the hotel.

LOCAL TRANSPORTATION

Travel between Hotel & Workshop

The workshop will provide shuttle buses to take participants between the Radisson Hotel and the workshop location at the U of S campus (Edwards School of Business Building, 25 Campus Drive, U of S).

These **buses are white, with a "Connoisseur Tours" emblem** on the side. **Departure** times are as follows:

Wednesday July 22

Afternoon: Radisson Hotel → Workshop:
3:30 pm
3:45 pm

Evening: Workshop → Radisson Hotel:
7:10 pm
7:25 pm

Thursday July 23

Morning: Radisson Hotel → Workshop:
7:30 am
7:45 am

Evening: Workshop → Radisson Hotel:
6:10 pm
6:25 pm

Friday July 24

Morning: Radisson Hotel → Workshop:
7:30 am
7:45 am

Evening: Workshop → Radisson Hotel:
3:40 pm
3:55 pm

During appropriate walking weather, a workshop volunteer (identified by *green* ***nametag stickers) will be available to walk fitness-oriented participants back from the workshop to the hotel.***

Other Local Transportation Needs

Taxis

Fares from airport to downtown is approximately $15 to $20 CAN.

1. United Blueline Cabs Ltd. licensed to operate taxicab services from designated pick-up and drop-off locations along the terminal curbside: (306) 652-2222.
2. Blueline Taxi: (306) 653-3333
3. Saskatoon Radio Cabs Ltd.: (306) 242-1221

Volunteers will be happy to assist you by calling taxis from the workshop. If you would like a taxi arranged from the workshop to the airport, just let a volunteer know the time at which you would like it to arrive, and they will take care of the arrangements.

Car Rentals

Airport rental vehicles are conveniently located in the parking lot just across from the terminal building.

Avis Car Rental: (306) 652-3434
Budget-Rent-A-Car of Saskatoon Ltd.: (306) 664-0670
Enterprise Rent A Car (306) 664-4454
National Car Rental (Canada) Inc.: (306) 664-8771 Ext 5
Thrifty Car Rental: (306) 244-8000

Bus Routes

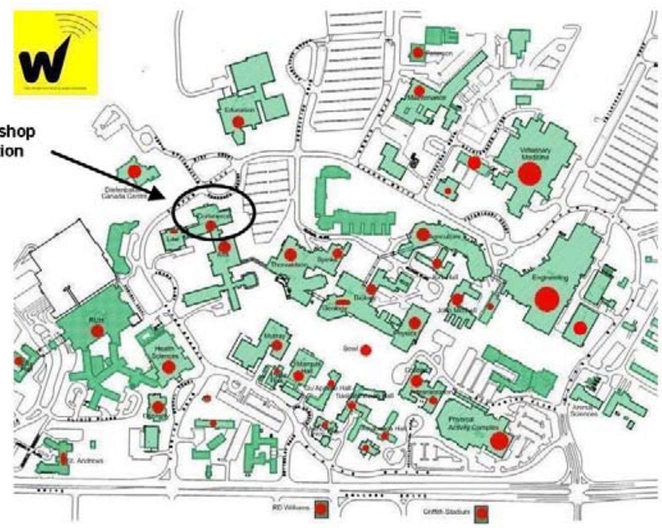
The Saskatoon Transit #11 Airport-Exhibition bus goes right to the Airport. Check the City of Saskatoon website at www.city.saskatoon.sk.ca/org/transit/routes_services.asp for routes and times.

The University of Saskatchewan campus includes one of the city's two major bus hubs; if you would like to catch a bus to/from campus, just let a volunteer know, and someone will escort you to/from the bus hub at Place Riel.

CAMPUS INTERNET ACCESS & INFORMATION TECHNOLOGY NEEDS

The U of S wireless network has guest wireless network services for workshop attendees. To access the guest wireless network, visitors will need to create a connection to the guest wireless network, identified by the "**guest**" SSID. (**NB**: be sure to use the guest network, rather than others available). Procedure:

1. Log in using the following guest credentials:
   User: *visitor*
   Password: *visitor*
2. If you are going to use the wireless network to access secure resources, establish a VPN or enable other security measures as appropriate.

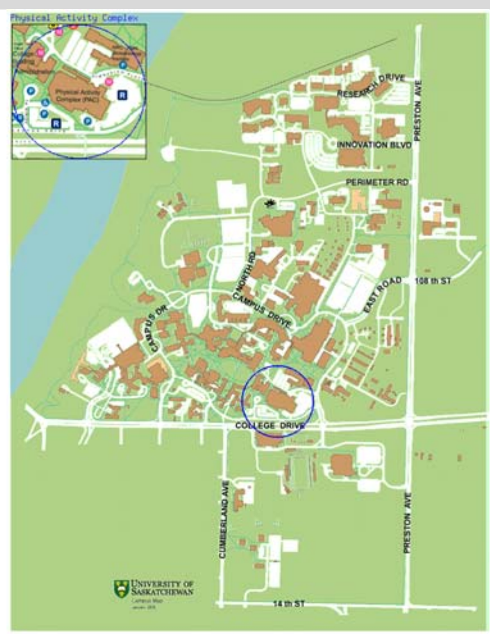


Skilled workshop IT volunteers (identified by red nametag stickers) are available to help you resolve connectivity problems. *U of S IT support is also available at (306) 966-4806.*
A small cluster of computers is located just to the left of the workshop as one emerges from the doors. While a valid U of S login is required, ***during Health Breaks volunteers will be stationed at these computers to log you in***.
IT volunteers will assist speakers in connecting their computers or transferring files for display from the theatre computer, and enable podcast (MP3) recording of talks. If prefer to opt out of the MP3 recording, just let the volunteer know prior to or following your talk. Throughout the workshop, volunteers will be available to update your USB drive or computer with updated presentations, presentation podcasts (MP3s) and workshop materials.

ATHLETIC FACILITIES

In addition to hotel facilities, workshop participants are welcome to use the facilities at the U of S Physical Activity Complex (PAC), located at 87 Campus Drive (just a short distance from the Faculty Club). This building features an Olympic-sized swimming pool, an indoor track, climbing wall and a large collection of modern exercise bikes, treadmills and weight machines. The daily user fee of $8.00 is paid directly to the fitness centre desk (located just down the front stairs, through the doors on the right as you approach the building). Summer hours of operation are;

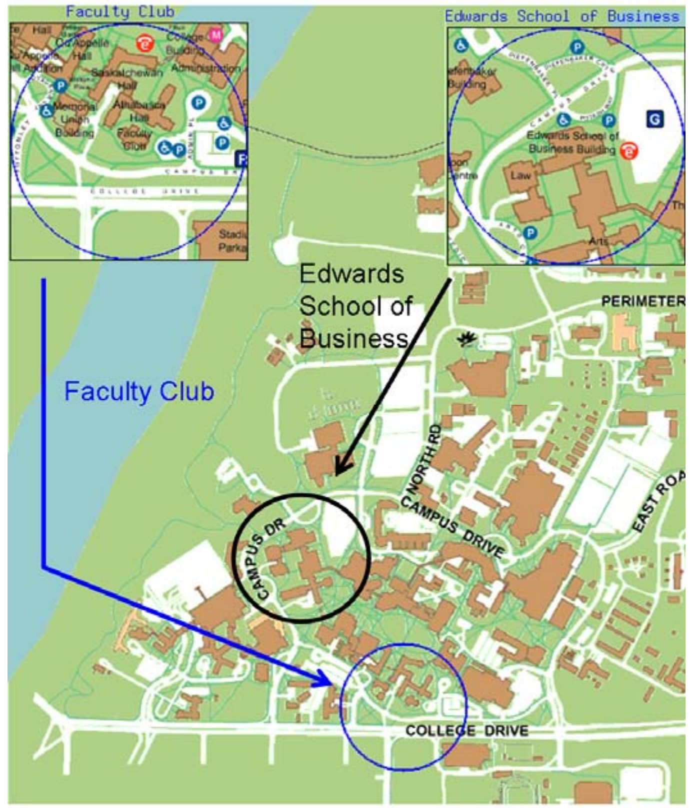
- Monday to Friday 6:30 am – 10:30 pm.
- Saturday and Sunday 8 am – 9 pm.



If you'd like to be guided to the Physical Activity Complex, just ask a conference volunteer and a volunteer will escort you to the PAC registration desk during lunch or at the end of the day.
For further information call Fit Centre Desk at (306) 966-1054 or Customer Service Desk at (306) 966-1052 or 966-1053. For a complete schedule of activities visit
http://kinesiology.usask.ca/community-programs/fit-centre

MEALS

Complimentary morning and afternoon beverages and snacks will be available to participants each day of the workshop. On July 23rd and 24th, buffet-style workshop lunches will be held at the University of Saskatchewan Faculty Club, located on campus at 101 Administration Place. Volunteers will be guiding workshop participants to and from the Faculty Club; but a map is provided to the right to allow participants to make their own way between the two locations if required.



Volunteers (identified by blue nametag stickers) will depart Faculty Club lunches 10 minutes early to take interested conference participants to see scenic & historic buildings on the campus on the way back from lunch.

Workshop participant may decide their own dining arrangements. However, to facilitate mixing & discussions outside the workshop we have arranged dining reservations at various local restaurants. Attendance is optional and we will be determining the number of interested participants prior to morning break each day to arrange reservations. Tentative locations are as follows, but may change based on expressed interest and restaurant capacity limitations.

- July 22 2nd Avenue Grill
- July 23 Calories Restaurant
- July 24 Truffles Bistro

For directions to these and other restaurants, see the maps located at the end of the binder.

The U of S campus offers a number of food outlets within easy walking distance of the workshop, including coffee shops (Tim Hortons & Starbucks), cafeterias and restaurants.

If you would like to find other food options, have dietary concerns or food allergies or wish to find out about additional food options, just speak to a workshop volunteer and they can direct you to other food locations or will seek to directly answer or research questions.

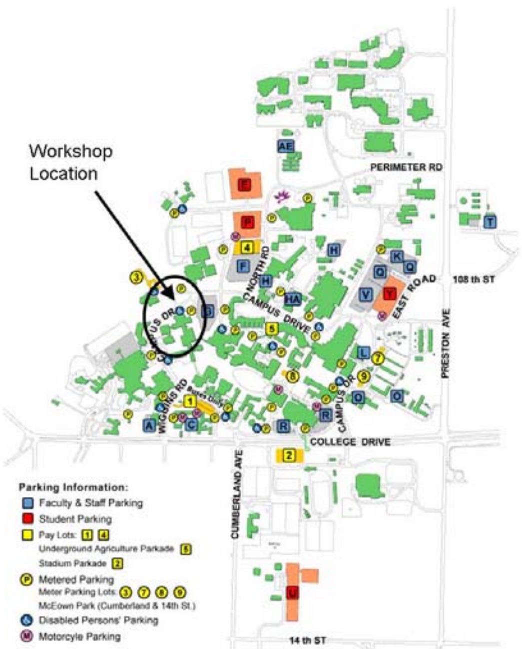
If you have any airborne food allergies (e.g. to peanuts), just alert volunteers and we will strive to ensure that appropriate precautions are taken.

CAMPUS PARKING

Meters and pay parking lots are available on campus.

Meters accept all coins including the Canadian “toonie”. (Some meters accept United States coins as well, but please note that they ignore the exchange rate, and you will thus get less value for your US dollar).
You can also use your cell phone to pay for meter parking by calling (306) 955-9969 and entering the four-digit meter number located on the meter sticker. Meters are in effect during the summer from 0730 to 2200 h. The cost and time limits vary depending on the meter location.

Please check posted signage.



Numerous pay lots are available on campus. The closest lot to the Commerce Building where the workshop will be held is Lot 5 located beneath the Agriculture Building – Science Place Access

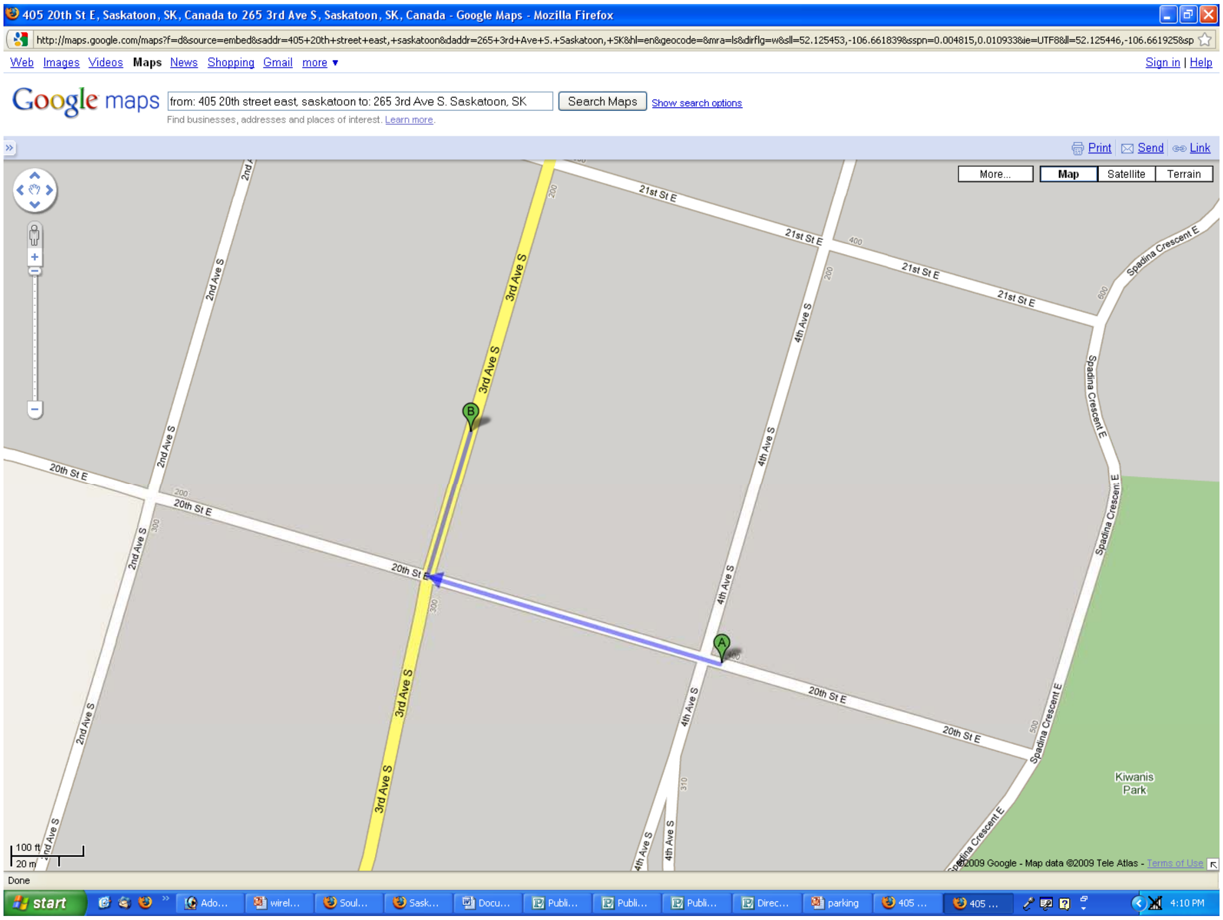
- Pay on exit, fully automated, unstaffed lot.
- In operation 24 hours per day, 7 days per week.
- $1.00 per half hour (or portion thereof).
- $10.00 (per exit) daily maximum.
- Accepts "prepaid cards" and cash denominations of $20 or less
- $3.00 (per exit) daily maximum

Parking Services: (306) 966-4502

SPONSORS

Souleio Restaurant

265 3rd Ave South., (306) 979-8102



Directions From Radisson Hotel

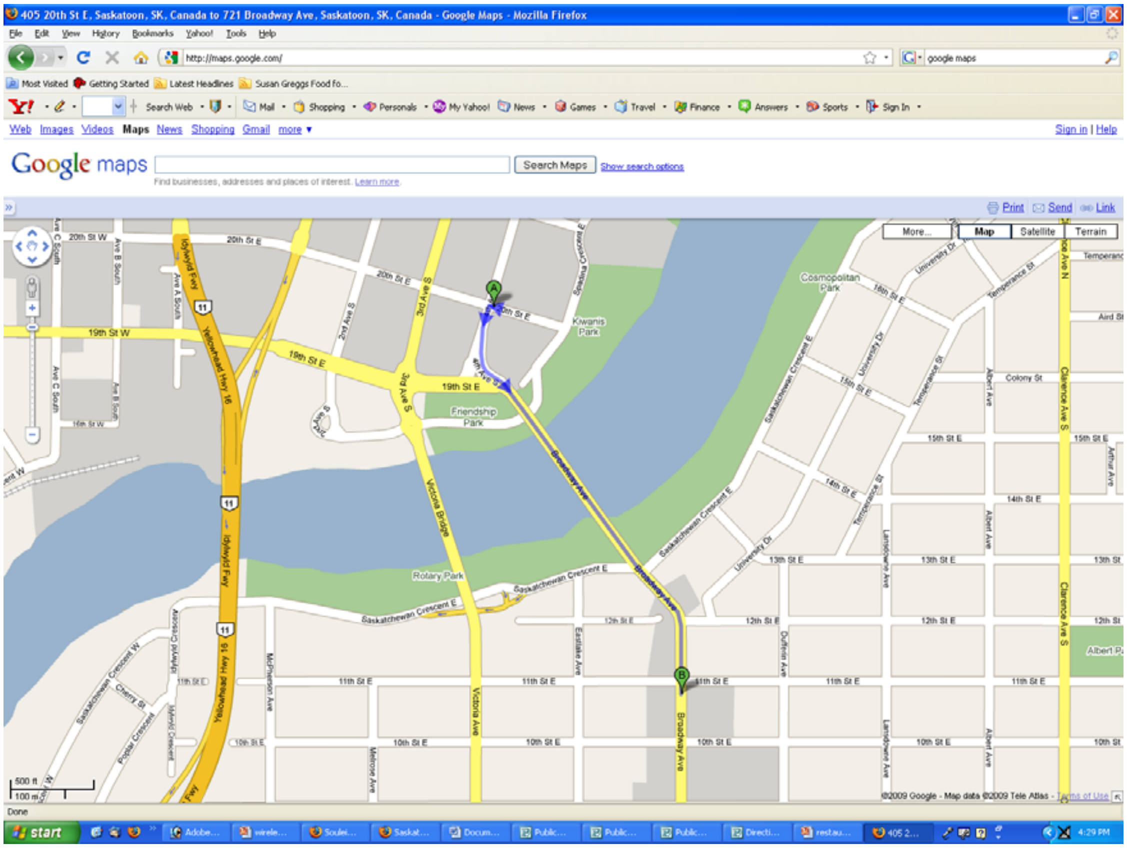
Total distance: 0.2 km, Duration: 2 minutes **walking**

- Head west on 20th St E toward 4th Ave S
- Turn right at 3rd Ave S

For complete menu:

http://souleio.com/menus-and-online-ordering/dine-in

Calories Restaurant
(tentative dinner venue, July 23rd)
721 Broadway Ave., (306) 665-7991



Directions from Radisson Hotel

Total distance: 0.8 km, Duration: 11 minutes **walking**

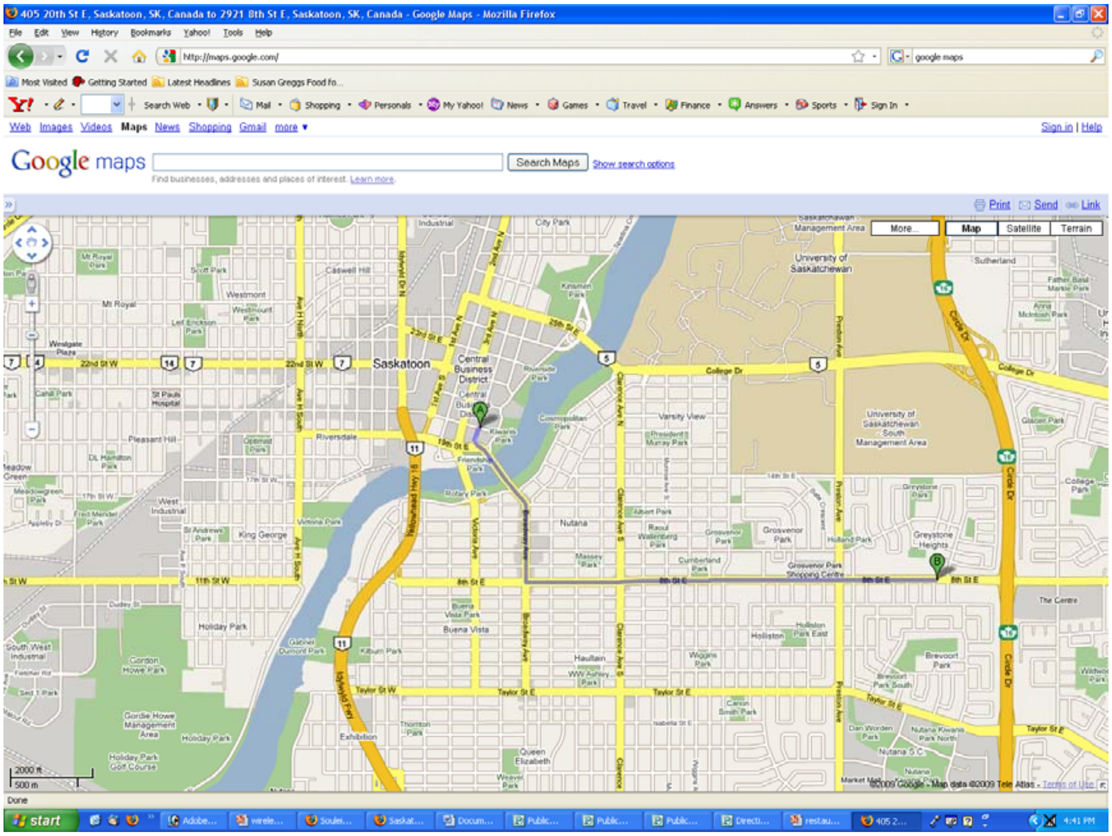
- Head west on 20th St E toward 4th Ave S
- Turn left at 4th Ave S
- Slight left to stay on 4th Ave S
- Continue on Broadway Ave

For complete menu:

http://www.caloriesrestaurants.com/menu.html

Avocado Restaurant and Lounge

2921 8th Street East, (306) 979-9588



Directions from Radisson Hotel

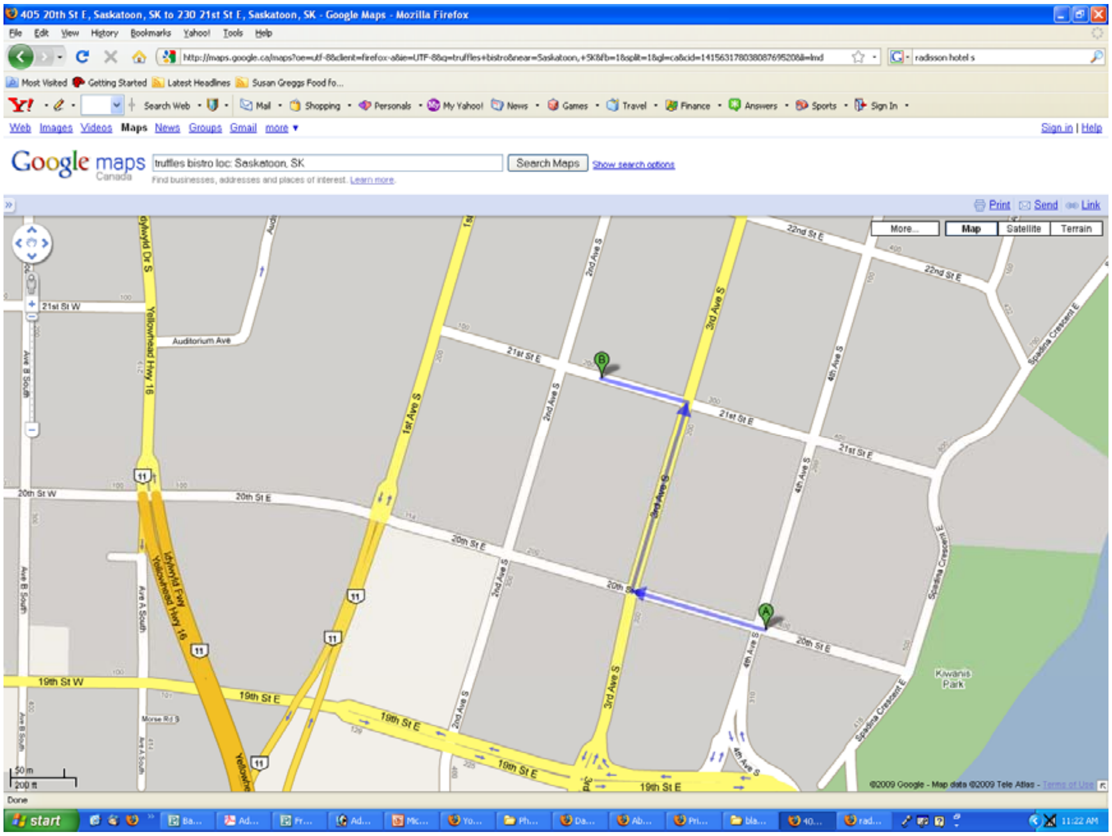
Total distance: 4.4 km, Duration: 7 minutes **BY CAR**

- Head west on 20th St E toward 4th Ave S
- Turn left at 4th Ave S
- Slight left to stay on 4th Ave S
- Slight right at 19th St E
- Continue on Broadway Ave
- Turn left at 8th St E Destination will be on the left

For complete menu:

http://www.avocadosgrill.com/menu.html

Truffles Bistro & Pattisserie
(tentative dinner venue, July 24th)
230 21st Street East, (306) 373-7779



Directions from Radisson Hotel

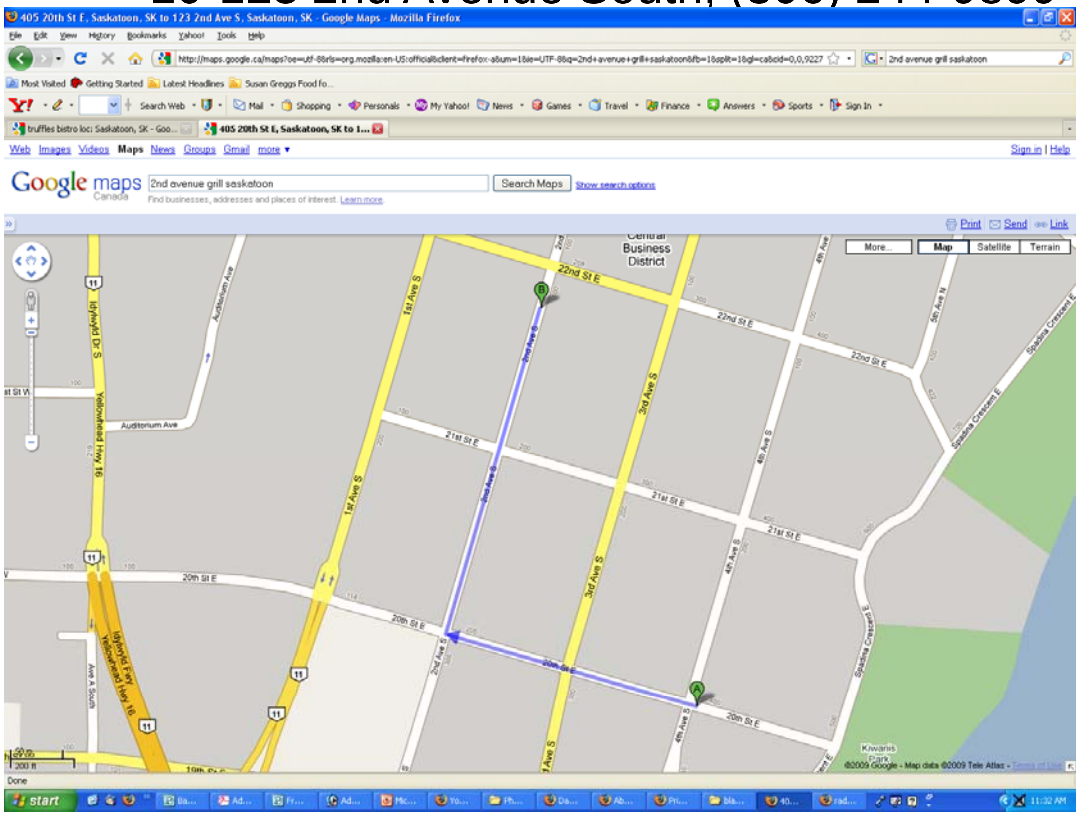
Total distance: 0.4 km, Duration: 4 minutes **walking**

- Head west on 20th St E toward 4th Ave S
- Turn right at 3rd Ave S
- Turn left at 21st St E

For complete menu:

http://trufflesbistro.googlepages.com/eveningmenu

2nd Avenue Grill
(tentative dinner venue, July 22nd)
10-123 2nd Avenue South, (306) 244-9899



Directions from Radisson Hotel

Total distance: 0.6 km, Duration: 7 minutes **walking**

- Head west on 20th St E toward 4th Ave S
- Turn right at 2nd Ave S

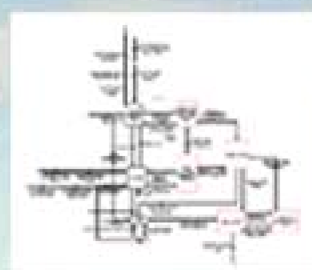
For complete menu:

http://www.2ndavegrill.com/our_menu.html

First Annual Workshop on Dynamic Modelling for Health Policy: Obesity & Obesity Related Chronic Disease

July 22 - 24, 2009

UNIVERSITY OF SASKATCHEWAN



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