

New Frontiers for Foods and Digestive Health

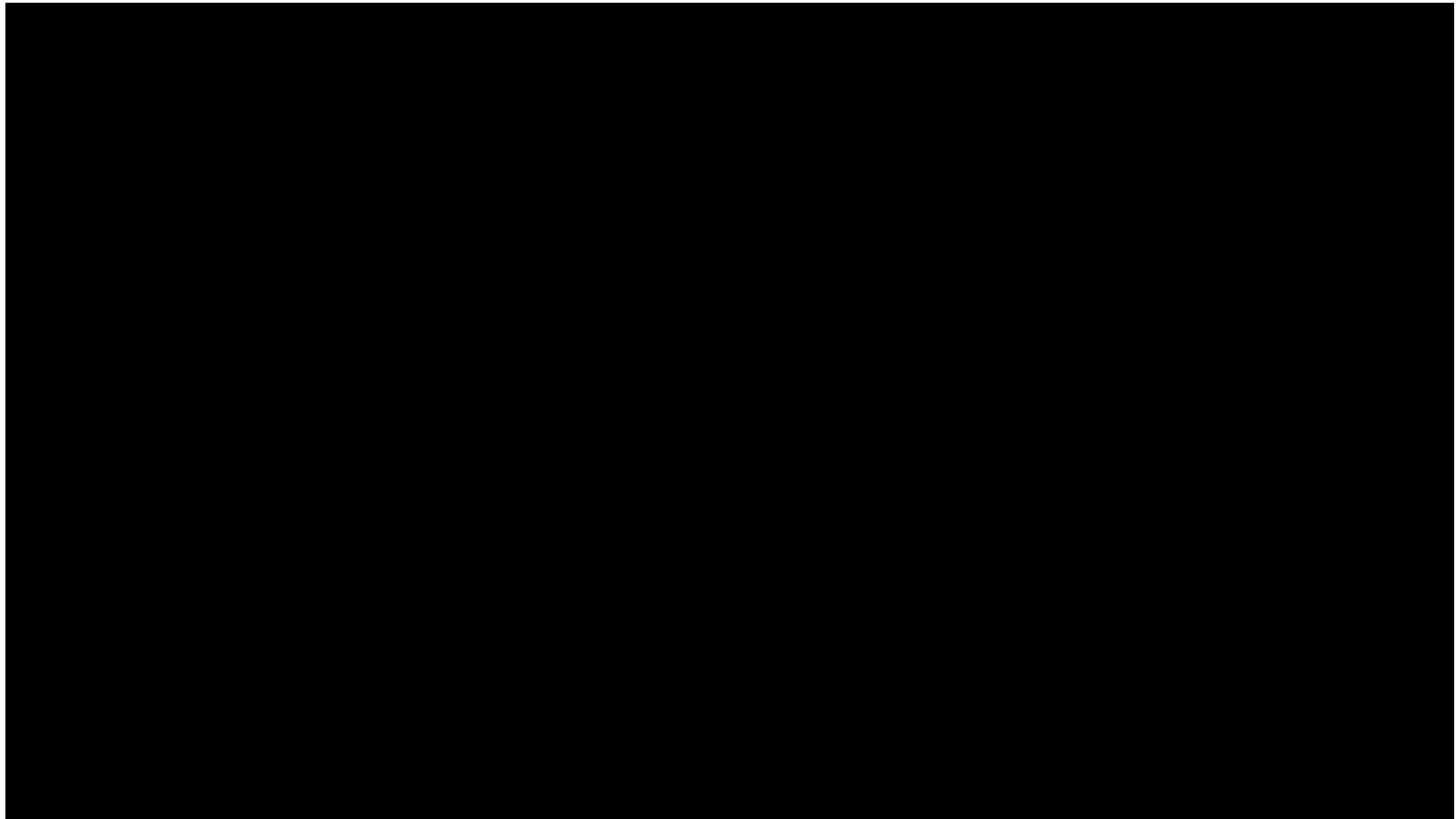
Professor Nicole Roy, Department of Human Nutrition,
University of Otago, High-Value Nutrition Leadership Team

Professor Richard Gearry, Department of Medicine,
University of Otago, Christchurch

Challenge Host



Challenge Collaborating Parties

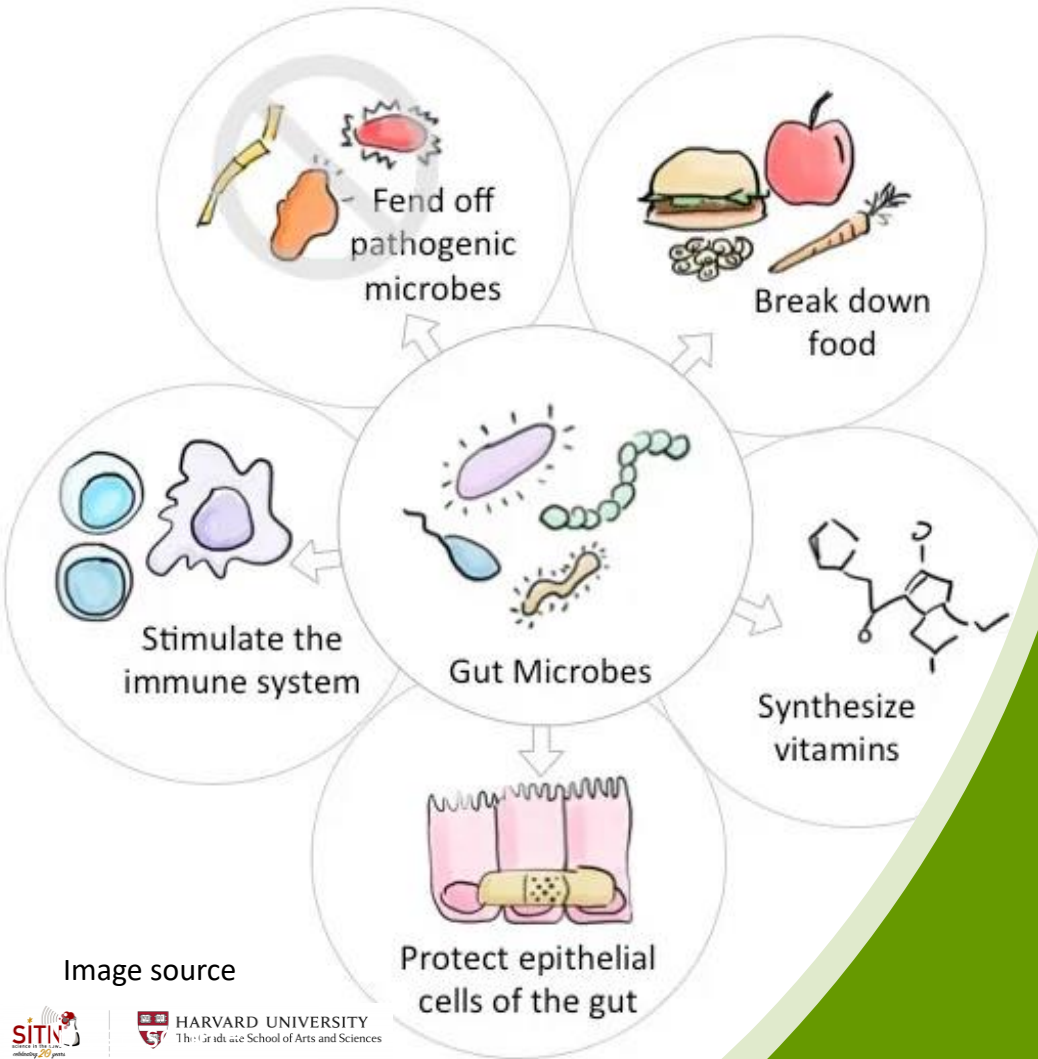


Animation courtesy of Hybrid Medical Animations (with permission)

National
Science
Challenges

HIGH-VALUE
NUTRITION

Ko Ngā Kai
Whai Painga



We are not alone

Image source



HARVARD UNIVERSITY
The Graduate School of Arts and Sciences

National **Science** Challenges

HIGH-VALUE NUTRITION

Ko Ngā Kai Whai Painga

What Does a Healthy Gut Do for Us?

Efficient digestion

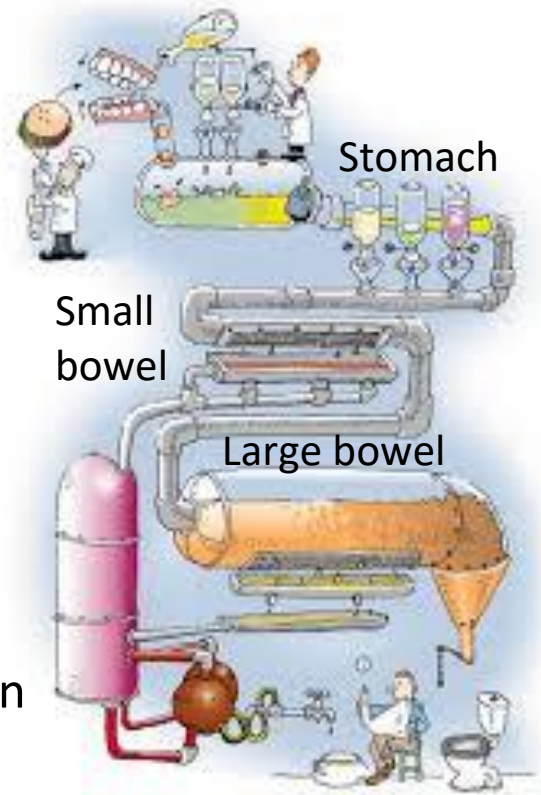
- Soft bulky stool
- Frequent bowel movement

Controlled inflammation

Intact mucous layer

Balanced microbiota

Composition/fermentation



Optimal laxation

Optimal transit time
(no constipation/diarrhoea)

Comfort

- No bloating
- No pain
- No excessive flatulence

Functional Gastrointestinal Disorders (FGID)

- Chronic gastrointestinal (GI) symptoms in the absence of demonstrable pathology on conventional testing
- Widespread and common, women > men
- 60% population worldwide suffers from GI discomfort
 - ~40% can be diagnosed with an FGID
- Most common FGID: Irritable bowel syndrome (IBS)
 - Abdominal pain linked to bowel movements
- Reduced quality of life, large economic impact
- **>80% people with IBS believe diet is effective**
- Interactions between diet-microbiota-host are important



THE LOW-FODMAP DIET
WHAT CAN I EAT?

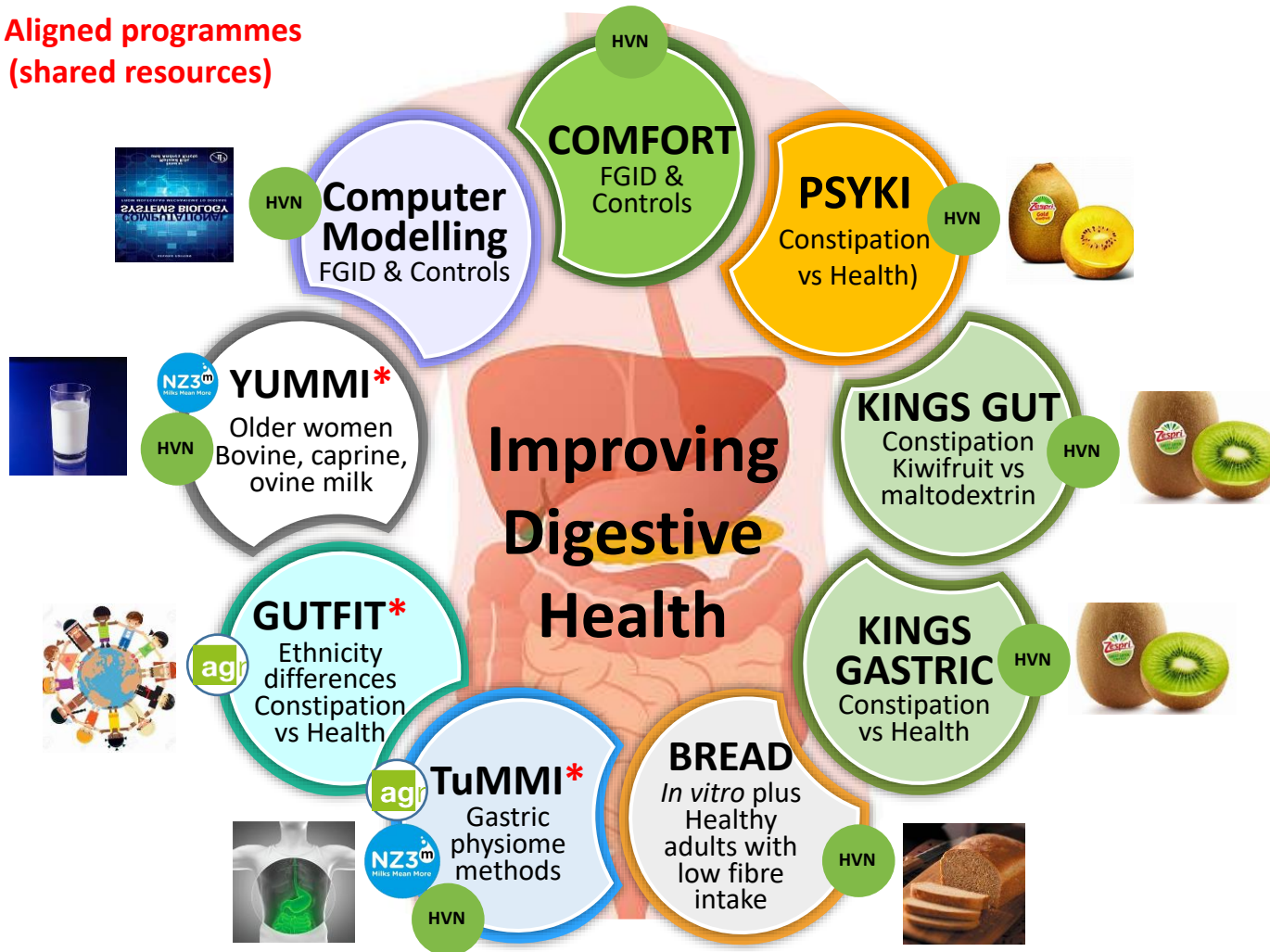
VEGETABLES, FRUITS, AND GRAINS

✓ YES	✗ NO
<p>Tomato, Eggplant, Zucchini, Carrot, Spinach</p>	<p>Garlic, Onion, Cauliflower or Broccoli, Mushrooms</p>
<p>Blueberries, Kiwi, Oranges, Strawberries, Pineapple</p>	<p>Apples, Peaches, Watermelon, Cherries, Pears</p>
<p>Brown rice, Oats, Quinoa, Polenta</p>	<p>All Wheat, Incl most Pasta, Rice Bread, Pastries, Barley</p>

The Studies



*** Aligned programmes
(shared resources)**



**Aligned HVN contestable
funded projects
(shared knowledge)**

SOOTHE (Otago, Dunedin)
Mānuka Honey for digestive health in adults
(Miller, Roy, Gearry, Gasser, McNabb)

SEA AU ORA (Otago, Dunedin)
Effects of Kopakopa on nutrition and digestion in healthy adults
(Miller, Roy, McNabb, Gearry, Schultz)

LINK (Auckland)
Polyphenol-rich drink for gut and brain
(Gillies, Braakhuis, Roy, Vataneen)



Cohort Profile: The Christchurch IBS cOhort to Investigate Mechanisms For gut Relief and Improved Transit (COMFORT)

Phoebe Heenan^a, Rob H. Greeners^a, Shriya Sharma^a, Jacqueline Keenan^a, Simone Bayer^a, Wayne Young^{a,c}, Janine Cooney^{a,f}, Kelly Armstrong^c, Karl Fraser^{a,c}, Paula M. Skidmore^a, Nicholas J. Talley^a, Nicole Roy^{d,e,h}, Richard B. Geary^{a,c} COMFORT Cohort Collaborators

Neurogastroenterology & Motility

Economic living standard and abdominal pain mediate the association between functional gastrointestinal disorders and depression or anxiety

*Simon MH^{1, 2}, *Heenan PE^{1, 3}, Frampton C¹, Bayer S^{1, 3}, Keenan JI^{3, 4}, Boer de NK², Roy NC^{3, 5}, Talley NJ^{6, 7}, Geary RB^{1, 3}

In Press

REVIEW ARTICLE



Irritable bowel syndrome and the gut microbiota

Phoebe E. Heenan^a, Jacqueline I. Keenan^b, Simone Bayer^a, Myrthe Simon^c and Richard B. Geary^a

^aDepartment of Medicine, University of Otago, Christchurch, New Zealand; ^bDepartment of Surgery, University of Otago, Christchurch, New Zealand; ^cDepartment of Medicine, Vrije Universiteit, Amsterdam, Netherlands

Questionnaires

- Rome IV Diagnostic Criteria
- SF-12 Quality of Life
- Medical History and Demographics
- Hospital Anxiety and Depression Scale
- Patient Reported Outcomes Measures Information System
 - Gastrointestinal
 - Emotional Distress
- Structured Assessment of Gastrointestinal Symptoms Scale

Standard Bowel Activity - Mean Score %

Please report your bowel activity using the following scale:

By Stool Type	None	1	2	3	4	5	6	7	8	9	10
1. Hard stool											
2. Soft stool											
3. Watery stool											
4. No stool											
5. No stool											
6. No stool											
7. No stool											
8. No stool											
9. No stool											
10. No stool											

Food and Symptom Times (FAST) Diary

- Combining a Diet diary with gastrointestinal symptoms
- Validated and published by our group previously
- Used to understand the relationship between food and gut symptoms

The image shows a detailed screenshot of the FAST (Food and Symptom Times) diary form. It includes sections for recording symptoms (e.g., abdominal pain, bloating, constipation, diarrhea), food and beverage intake (e.g., breakfast, lunch, dinner, snacks), and stool characteristics (e.g., frequency, consistency, color). There are checkboxes for 'None' and 'Yes' for various symptoms, and a grid for recording food intake over time.

Biological Samples



Metabolomics
Neuromarkers
PBMCs
Immune markers
DNA
Biobank



Volatile Metabolites



Untargeted metabolomics
Targeted metabolomics
16s DNA
Metagenome DNA
Biobank metagenome RNA
Biobank



Biobank



Biobank

Food and Symptom Times (FAST) Diary

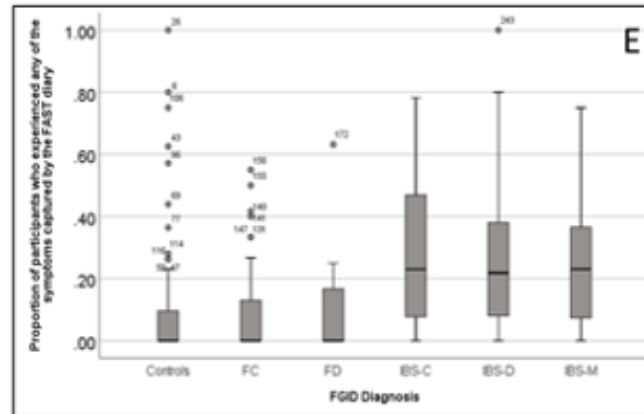
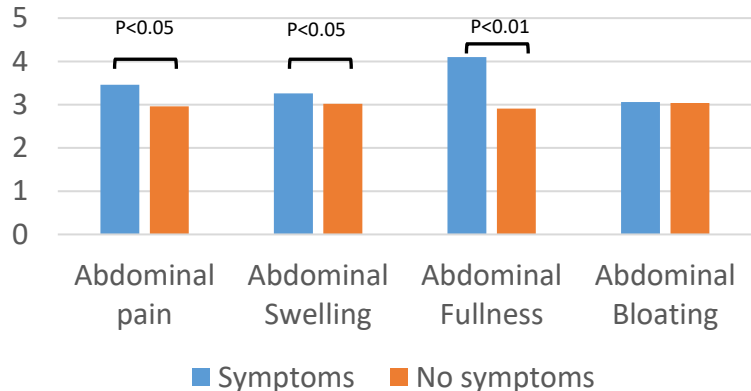
Aligning what we eat with how we feel



Phoebe Heenan

- GI Specialist Dietitians take a detailed food and symptom history
- Clinically useful but not translated to a research tool
- Low FODMAP diet and ?fibre reduces GI symptoms in those with IBS

FODMAP intake with and without symptoms



Wright-McNaughton *et al.* (2019). *Clinical Translational Gastroenterology* 10(12):e00103.

Heenan *et al.*
Submitted to *Frontiers in Nutrition Clinical Nutrition Section*

Functional GI Symptoms

More than just what we eat?

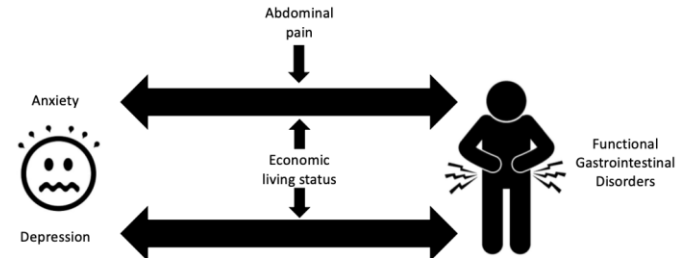


- FGID have been renamed “Disorders of Gut-Brain Interaction”
- COMFORT Cohort: study multiple drivers of GI symptoms including anxiety and depression using validated patient reported outcomes
- Relationship between psychological factors and FGID compared with controls
 - Anxiety OR 2.9 [95%CI 1.6-4.9]
 - Depression OR 3.4 [95%CI 1.4-8.5]
- Lower economic living standard and abdominal pain mediates this association

Neurogastroenterology & Motility

Economic living standard and abdominal pain mediate the association between functional gastrointestinal disorders and depression or anxiety

*Simon MH^{1,2}, *Heenan PE^{1,3}, Frampton C¹, Bayer S^{1,3}, Keenan JI^{3,4}, Boer de NK², Roy NC^{3,5}, Talley NJ^{6,7}, Geary RB^{1,3} In Press



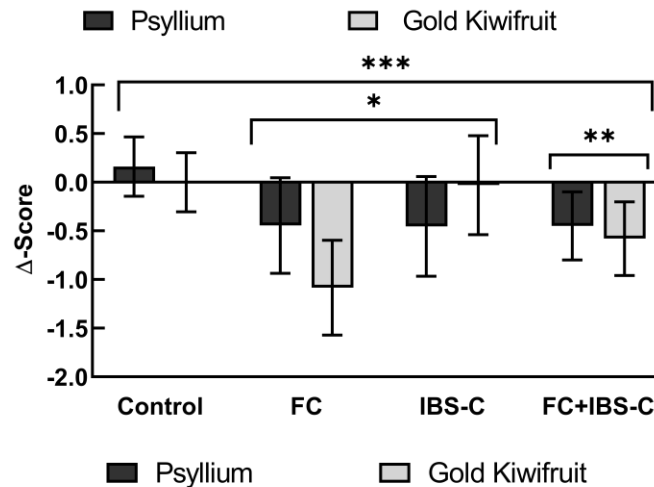
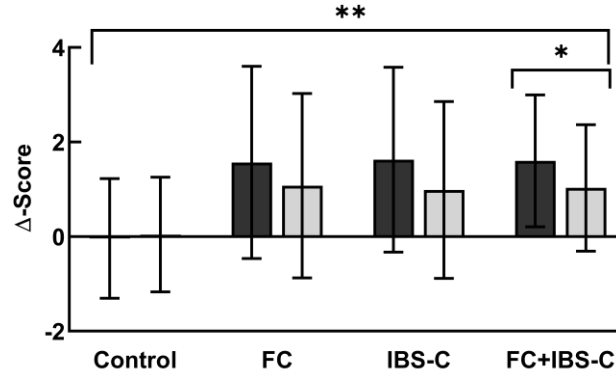
The PSYKI Study



Diana Cabrera

Biological markers

- Plasma & faecal metabolites
- Faecal microbiota



Simone Bayer

GI symptoms

- Increased complete spontaneous bowel movements
- Reduced constipation

Bayer *et al.*
Submitted to *Nutrients*



Collaborations to advance knowledge in digestive health

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SCIENCE
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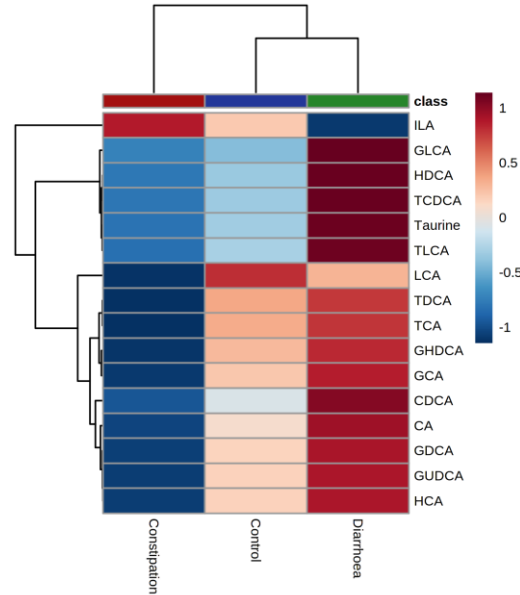
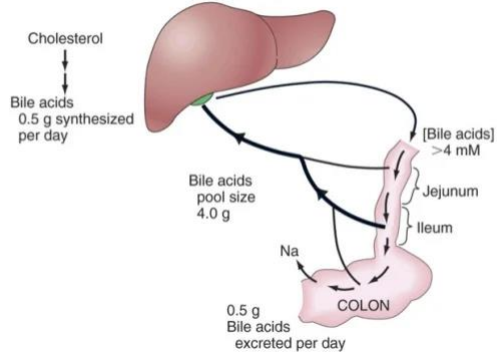


Article

Concentrations of Fecal Bile Acids in Participants with Functional Gut Disorders and Healthy Controls

Shanalee C. James ^{1,2,3,4}, Karl Fraser ^{1,3,4}, Wayne Young ^{1,3,4}, Phoebe E. Heenan ^{4,5}, Richard B. Gearry ^{4,5}, Jacqueline I. Keenan ⁶, Nicholas J. Talley ⁷, Susan A. Joyce ⁸, Warren C. McNabb ^{1,4} and Nicole C. Roy ^{1,4,9}

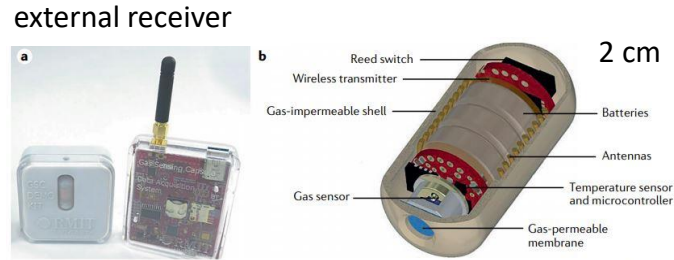
Biosynthesis of lipids and cholesterol



- Lower in **Constipation** likely due to increased transit time and decreased faecal output
- Higher in **Diarrhoea** likely due to perturbed transit time and bile acid reabsorption

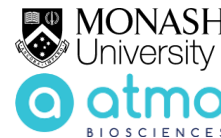
Bile acids: chemical detergents aid digestion and absorption of nutrients

Gas Production along the GI Tract



- Capsule developed by RMIT University and commercialised by Atmo Biosciences
- Measure gas (carbon dioxide and hydrogen) production along the GI tract
- Oxygen tracks location in the GI tract
- Temperature sensor indicates when the capsule has exited
- Used in KINGS GUT and BREAD studies

Kalantar-Zadeh *et al.* (2018; 2019) *Nat Electron* 1:79-87; *Nat Rev Gastroenterol Hepatol* 6(12):733-747.



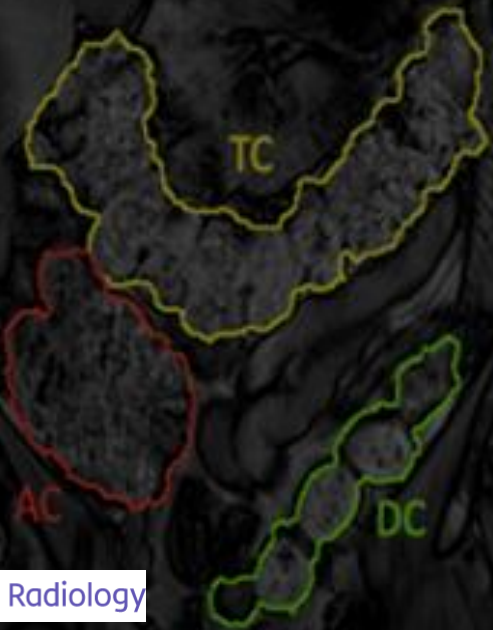
Jasjot Maggo



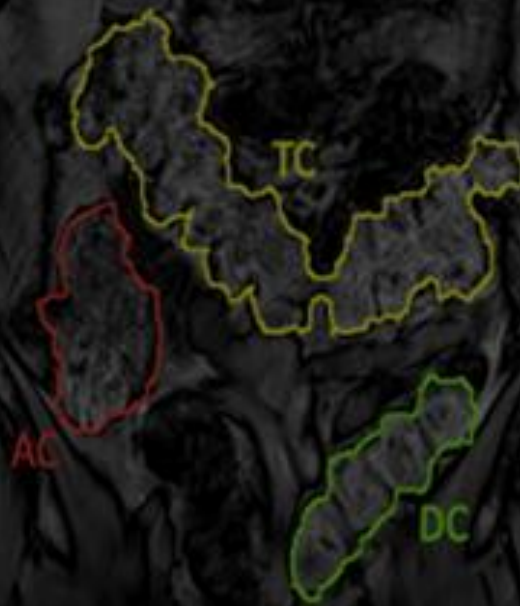
Hwei Min Ng



Colonic volume by magnetic resonance imaging (MRI)

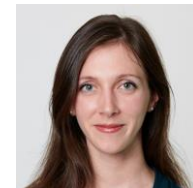


Baseline

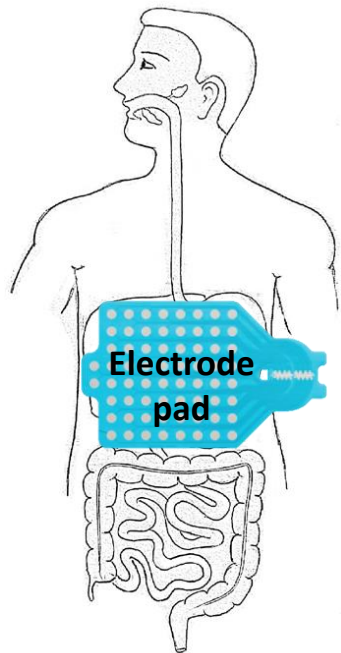


Post-Intervention

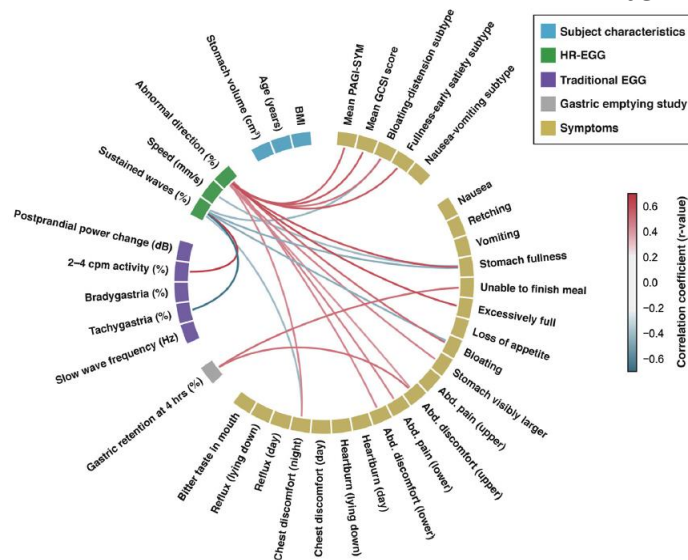
Body Surface Gastric Mapping



Amber Milan



- Captures gastric electrical activity
- Dysfunctional activity patterns correlate well with gastric symptoms
- Trialled in TuMMI
- Using in KINGS GASTRIC



Alimetry™ (FDA approved)



AUCKLAND BIOENGINEERING INSTITUTE

Gharibans *et al.* (2019). *Clinical Gastroenterology and Hepatology* 17.13:2668-2677.



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Growing the Scientist Community

- **Postdoctoral Fellows (8)**

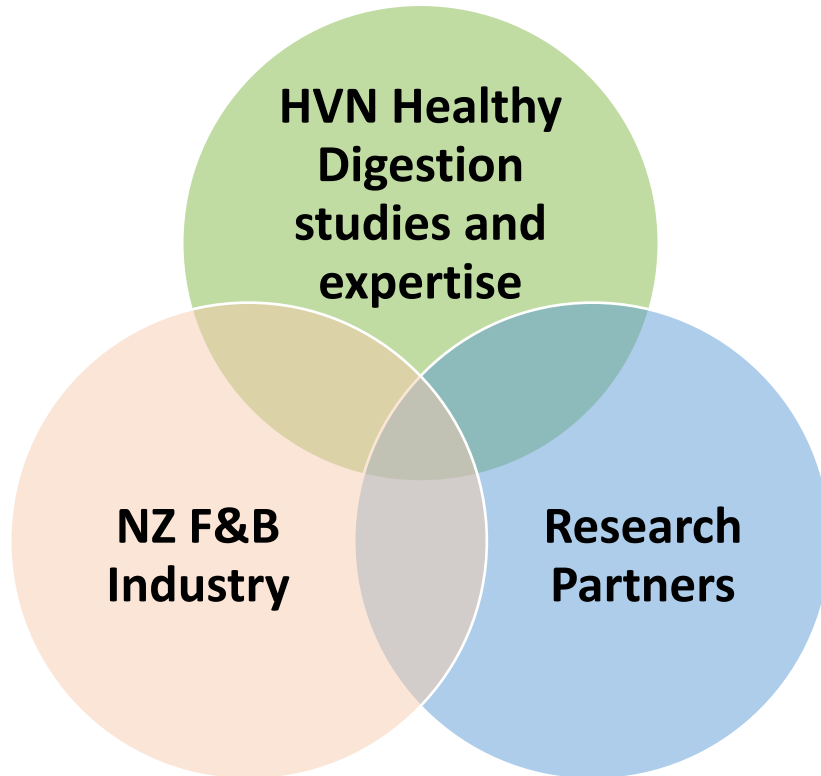
- Dr Simone Bayer, Research Fellow, University of Otago
- Dr Jane Mullaney (Ngāti Porou, Ngāti Raukawa), Senior Researcher, AgResearch
- Dr Diana Cabrera, Postdoctoral Fellow, AgResearch
- Dr Amber Milan, Postdoctoral Fellow, University of Auckland and AgResearch
- Dr Jarrad Dowrick, Postdoctoral Fellow, University of Auckland
- Dr Catrin Guenther, Postdoctoral Fellow, Plant and Food Research
- Drs David O'Sullivan and Jeffry Tang, Malaghan Institute of Medical Research

- **Students (18)**

- Dr Phoebe Heenan: Researcher, NZ Clinical Research, Christchurch
- Dr Shanalee James: Postdoc, Cornell University, USA
- Caterina Carco: Postdoc, Humanitas University, Milan, Italy
- Jasjot Maggo: PhD Scholar, University of Otago
- Hwei Ming Ng: PhD Scholar, University of Otago
- Vitor G. Da Silva: PhD Scholar, Massey University (with Infant Health)
- Simone Frame (Ngāti Rangitane/ Ngāti Kahanunu/ Ngāti Maniapoto): MSc, Massey University (with Infant Health)
- 3 MDiet Students, 3 Pūhoro Interns, 5 Summer or Casual Students



Studies Designed with NZ F&B Industries



- Cash and in-kind co-funding for food intervention studies
- Shared knowledge to develop HVN contestable projects
- Industry placements
- Enabling Māori F&B industries

Thank you Participants, Industries, and...

Healthy Digestion Team & Host

Nicole Roy
Richard Gearry
Simone Bayer
Catherine Wall
Phoebe Heenan
Jasjot Maggo
Hwei Min Ng
Karin Schofield
Karl Fraser
Jane Mullaney
Diana Cabrera
Wayne Young
Panjaka Sharma
Meika Foster
Eric Altermann

Tim Angeli-Gordon
Jarrad Dowrick
Warren McNabb
Callum Tatton
Simone Frame
Vitor G. Da Silva
Caterina Carco
Shanalee James
Janine Cooney
Tania Trower
Catrin Guenther
Lucia Ying
Olivier Gasser
David O'Sullivan
Jeffrey Tang

University of Otago

The Nicholls Centre Team
Gastroenterology and Endoscopy Specialist Reception Team
Department of Human Nutrition



Warren McNabb

Nicole Roy
Richard Mithen
Amber Milan
Matthew Barnett
Karin Schofield



NZ Collaborators



Greg O'Grady

Armen Gharibans
Peng Du
Tim Angeli-Gordon



Matthew Barnett

Karl Fraser
Wayne Young
Amber Milan



International Collaborators

Nick Talley, Expertise in functional gut disorders, COMFORT

Peter Gibson, Expertise in gut physiology. KINGS GUT, BREAD

Kyle Berean, Malcom Hebblewhite, Gas profiling, KINGS GUT, BREAD

Robin Spiller, Luca Marciani, Caroline Hoad, Gut MRI, KINGS, TuMMI

Susan Joyce, Paul Cotter, Bile acid metabolism and sequencing, COMFORT



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