AI. Wellness
Influencing Dietary Trend and Lifestyle Choices in Managing Chronic Diseases

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National University of Singapore
• Motivations: the rise and rise of chronic diseases
• AI.Wellness Research and System
• Translational Deployment in Medical Institutions
• Summary
• 7 out of 10 deaths are caused by chronic diseases worldly.
World diabetes cases expected to jump 55% by 2035

Current and projected cases of diabetes by region:
- South and Central America: 59.8%
- Africa: 109.6%
- North America/Caribbean: 37.3%
- Middle East/North Africa: 96.2%
- Europe: 22.4%
- Southeast Asia: 70.6%
- Western Pacific: 46.0%

Top 10 countries by number of people with diabetes in 2013, ages 20 to 79:
- China: 98.4 million
- India: 65.1
- U.S.: 24.4
- Brazil: 11.9
- Russia: 10.9
- Mexico: 8.7
- Indonesia: 8.5
- Germany: 7.6
- Egypt: 7.5
- Japan: 7.2
China has a large burden of diabetes.

Annual Projected Cost of ¥360 Billion by 2030 on diabetes.

Diabetes in China: a societal solution for a personal challenge
Chan, Juliana C N et al. The Lancet Diabetes & Endocrinology, Volume 2, Issue 12, 969 - 979
Diabetes: The looming public health crisis threatening to take down China’s health care system

China’s hospitals are not equipped for the coming floods of patients.
Risk factors are widespread

– Unhealthy Diet
– Physical Inactivity

Paul Zimmet: Professor of Diabetes at Monash University
Honorary President of the International Diabetes Federation
Lifestyle + Environment > Medicine

World Health Organization

- 20% - genetics
- 10% - medical healthcare
- 50% - lifestyle
- 20% - environment

70% is lifestyle
Disruptive healthcare:
Reduce Cost of Care while Improving Quality of Life
Machine Intelligence + Healthcare

How Apps Can Help Manage Chronic Diseases

Hospitals and doctors have identified digital tools that can assist patients in dealing with ailments such as diabetes, heart disease and lung disease. The early results are promising.

Health and Wellbeing:

Self-tracking phenomenon by actively entering data or passively via sensors, gadgets and apps. Track sleep, eating habits, sex, moods, fertility patterns, physical & emotional health (glucose levels, blood pressure).

Over 100,000 health apps available for smartphones.

In the US:

69% of Americans track their health stats, either through technology or in their heads.
60% track diet, weight and exercise.
2/3 of those who self-track don't share their data with others.
34% of self-trackers say the practice affected a health decision.

In the UK:

7 in 10 British adults track their health.
Nearly half of adults in the UK who self-track with mobile devices say they've experienced "strong behaviour change."
25% of adults aged 25-44 said motivational prompts through their smartphone would have a huge effect on their health choices.
Dietary Tracking Apps
(in Western Countries)

<table>
<thead>
<tr>
<th>App Name</th>
<th>Record by Photo</th>
<th>Food Photo Recognition</th>
<th>Record by Search</th>
<th>Record by barcode scan</th>
<th>Record by free text</th>
<th>Rating out of 5</th>
<th># Rating</th>
<th>Launch time</th>
<th># Download</th>
</tr>
</thead>
<tbody>
<tr>
<td>MyFitnessPal</td>
<td>N</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.6</td>
<td>1,000,000</td>
<td>2005</td>
<td>50,000,000</td>
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<tr>
<td>FatSecret</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.4</td>
<td>193,000</td>
<td>2007</td>
<td>10,000,000</td>
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<tr>
<td>Noom Coach</td>
<td>N</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.3</td>
<td>166,000</td>
<td>2010</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Lose It!</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.4</td>
<td>55,000</td>
<td>2011</td>
<td>5,000,000</td>
</tr>
<tr>
<td>Sparkpeople</td>
<td>N</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.4</td>
<td>22,000</td>
<td>2012</td>
<td>1,000,000</td>
</tr>
<tr>
<td>MyNetDiary</td>
<td>N</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.5</td>
<td>18,000</td>
<td>2010</td>
<td>1,000,000</td>
</tr>
<tr>
<td>MyPlate</td>
<td>N</td>
<td>NA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>4.6</td>
<td>16,000</td>
<td>2010</td>
<td>1,000,000</td>
</tr>
</tbody>
</table>

60% of people in US track their diets, weight and exercise

50% in UK who self-track with mobile devices experienced “strong behavior change”
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Our Application: DietLens

- **Food recognition**: Recognize a dish photo through deep learning tech.
- **Food and activity diary**: Easy to record your everyday diet, extract daily activity from your smartphone—more convenient.
- **Analysis report**: Give users weekly or monthly report about their diet.
- **Bespoke recommendation**: Combining medical knowledge graph, personal profile to customize recommendation and encouragement.
- **Gamification**: Small incremental task and targets to help earn badges and achievements milestone.
DietLens

250+ Now support 250+ local food recognition
Adding more as we progress

125k Build on around 125k food images and growing

250+ Now support 250+ local food recognition
Adding more as we progress
Food Photo-Based Dietary Tracking

Behavior influence

- Noom Coach
- Sparkpeople
- MyPlate
- MyNetDiary
- MyFitnessPal
- Lose It!
- FatSecret
- DietLens

Inputting efficiency
<table>
<thead>
<tr>
<th>No</th>
<th>NExT++ Research Focuses</th>
<th>AI Wellness Research Specialties</th>
</tr>
</thead>
</table>
| 1  | Unified deep representational learning framework that handles all variety of content items including text, image, video, 3D data, as well as knowledge and user models. | RS1: Medical knowledge graph construction from heterogeneous sources.  
RS2: User data fusion from social media, smartphone, body sensors, clinic tests, DNA analysis |
| 2  | Multi-source multimodal multi-task learning framework that fuses data from multiple social networks and Web resources. | RS3: User medical profiling at four levels: general bio features, sub-population feature, fixed individual parameter, and dynamic individual parameters  
RS4: User community identification for diseases and different stages of each disease |
| 3  | User communities understanding in different vertical domains: personal and group profiling, actionable analytics and privacy technology. |  
RS5: Natural language and multimedia content generation: intervention messages. |
| 4  | Basic machine learning framework to support scalable and continuous learning. | RS6: Recommendation based on online learning of user profile and context: intervention administration.  
RS7: Deep Based Food and Nutrition Image Recognition |
| 5  | Innovative applications in wellness, e-services, and towards smart nation services. | RS8: Wellness applications for patients, hospitals, enterprises, and government. |
Multi-task DCNN

Given a picture of dish with unknown food category, recognize the dish name and the ingredients.
Cooking and Cutting Methods → Refined Nutrition Information

- Deep fry → high fat
- Heavy gravy → high sodium
- Finely processed → easy digest (high GI)
Six Major Nutrition Databases Cover Worldwide Food Types
Packaged Food Nutrition Databases of 20 Million Foods
Harvard Special Medical Reports for Major Chronic Diseases
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522 people  All with impaired glucose tolerance (risk factor)
• av. age 55
• BMI 31 kg/m²

Intervention:  individual counselling for weight loss and dietary improvement
• ↓total fat, ↑fibre, ↑exercise etc.

Outcomes:  intervention group lost 4.2 kg c.f. 0.8 kg in control group
• after av. 3.2 years

Diabetes incidence:  58% reduction in risk of developing diabetes
• 11% in intervention group c.f. 23% in control group

Main interventions

- Meal replacement (Protein-Rich-Meal-Replacement)
- Daily step and weight logging,
- Weekly care call from diabetes coaches.


West-German Centre of Diabetes and Health, Düsseldorf Catholic Hospital Group, German Institute for Telemedicine and Health promotion
Two institutions:

- National University of Hospital System
- Singapore Institute of Clinical Sciences, A*star

Target trial groups (longitudinal studies):

- Diabetes: NUHS (3k participants) Prof. Chong Yap Seng, Prof. Sue-Anne Toh
- Obesity: NUHS (1k participants) Prof. Chong Yap Seng
- Child Nutrition: GUSTO (2k participants) Prof. Mary Chong
- Nutrition Accuracy: Prof. Jeya Henry, Prof. Ciaran Gerard Forde
Diabetes Cohorts

**Gestational Diabetes Cohort**
- 1000 GDM patients at NUH/KK each year
- Prof. Chong Yap Seng
  - Senior Consultant in the Department of Obstetrics & Gynaecology, NUH
  - Executive Director for Singapore Institute for Clinical Sciences
  - Founding Director of A*STAR-NUS Singapore Centre for Nutrition Sciences, Metabolic Diseases, and Human Development (SiNMeD)

**Community Diabetes Cohort**
- Type 2 diabetes
- 2300 people without the condition
- Prof. Sue-Anne Toh
  - Endocrinologist
  - Clinical Director, Regional Health System Planning and Development
Diabetes Cohorts
App based tracking and intervention

Gestational Diabetes Cohort

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[Image of food and blood glucose meter with a reading of 75 mg/dL]
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<tr>
<th><strong>GUSTO Birth Cohorts</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Growing up in Singapore Towards Healthy Outcomes</strong></td>
</tr>
</tbody>
</table>

- 1200 women+ children (2009-2010) with detailed longitudinal observations and samples
- One of the most intensive birth cohorts in the world
- How conditions in pregnancy and early childhood influence the health and development of women and children.

**Collaborative research**

- National University Hospital
- KK Women’s and Children’s Hospital,
- A*STAR’s Singapore Institute for Clinical Sciences
- Researchers in New Zealand, UK, and other countries.
GUSTO: Replace Frequent Food Questions with DietLens
Clinical Nutrition Research: Validation & Innovation

THE STRAITS TIMES
Scientists seek to boost health of Asians by modifying food

NEXT++
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• Chronic Disease epidemic is preventable and manageable through patient-centered lifestyle intervention, which is low-cost but challenging.

• We have researched and developed DietLens, food image recognition based dietary tracking and nutrition-based intervention.

• We have established collaborations with a few key partners from medical side in Singapore to inject and validate in-depth knowledge of the system.
Work and Live Toward Wellness

http://www.jianshu.com/u/d44e4ca11543