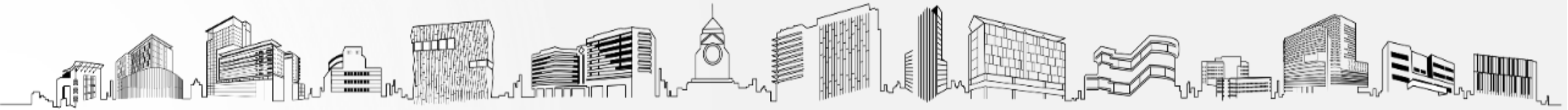


Inter-disciplinary and Multi-sectoral Collaborations for Impactful Population Health and Societal Outcomes

Assoc Prof Low Lian Leng

Director, SingHealth Centre for Population Health Research and Implementation

Director, Population Health and Integrated Care Office, Singapore General Hospital

Medical Director & Senior Consultant, Outram Community Hospital

NMRC Awards Ceremony and Research Symposium 2023
27 April 2023

SingHealth DukeNUS ACADEMIC MEDICAL CENTRE

PATIENTS. AT THE HEART OF ALL WE DO.®

Singapore General Hospital | Changi General Hospital | Sengkang General Hospital | KK Women's and Children's Hospital | National Cancer Centre Singapore | National Dental Centre Singapore | National Heart Centre Singapore | National Neuroscience Institute | Singapore National Eye Centre | SingHealth Community Hospitals | Polyclinics SingHealth

Presentation outline

01 Opportunities and Challenges in Population Health

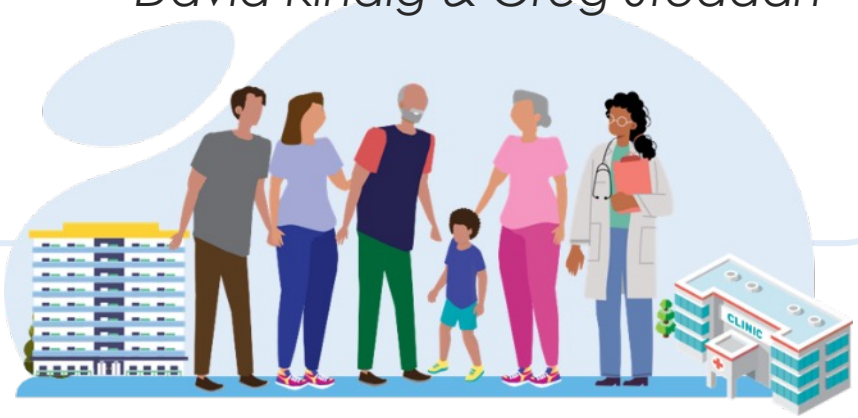
02 SingHealth Centre for Population Health Research and Implementation

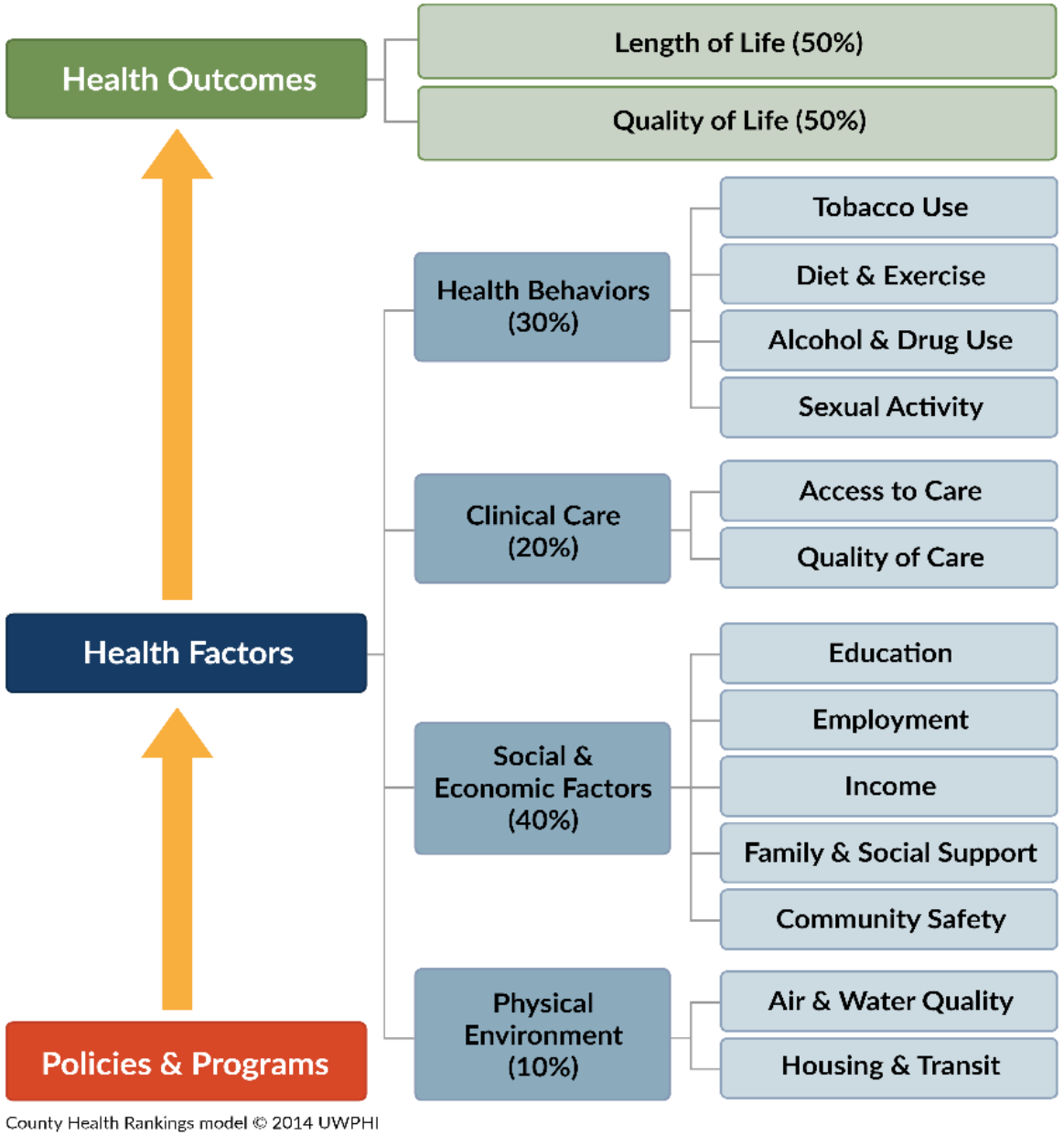
03 Inter-disciplinary and Multi-sectoral Collaborative Teaming for Greater Impact

Population Health Definitions

"The health outcomes of a group of individuals, including the distribution of such outcomes within the group and the policies and interventions that link outcomes and patterns of health determinants."

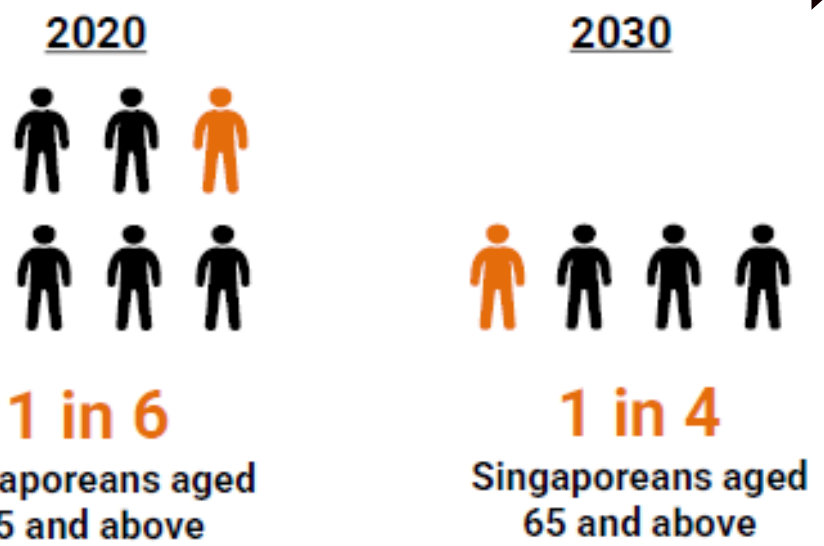
David Kindig & Greg Stoddart





Challenges and Opportunities with an Ageing Population

1 in 4 Singaporeans ≥ 65 y.o. in 2030, from around 1 in 6 in 2020



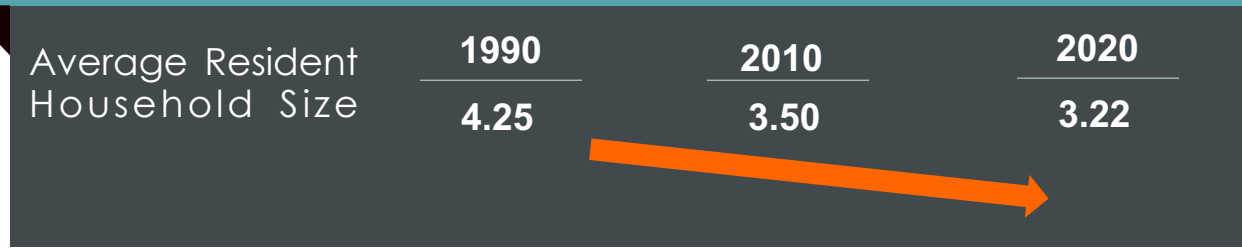
We will have over **900,000 seniors.**

Source: Ministerial Committee on Ageing "I Feel Young SG" website

Resident old age support ratio falling

Source: Department of Statistics, Singapore

Household size is also shrinking, making care more dependent on fewer people



Source: MSF study on Families and Households in Singapore, 2010-2020

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SingHealth Centre for Population Health Research and Implementation (CPHRI)

Nexus for Population Health Research & Implementation in SingHealth and Nationally

Accelerate translation of research findings to care delivery

SingHealth Population Health Academic Advisory Panel

To provide independent advice and guidance for the development, implementation and evaluation of population health research and initiatives in SingHealth

CHAIRPERSON

Prof Lee Chien Earn

DGCEO (RHS), SingHealth

MEMBERS

Renowned local and international members from diverse backgrounds

MSF Ministry of Social and Family Development

World Health Organization Centre for Health Development

Housing & Development Board

Duke University School of Medicine

Ministry of Health Singapore

Singapore Institute of Technology

SingHealth

CPHRI's wide range of collaborators

PULSES II Centre Grant

(Awarded $14M from Apr 2022 to Mar 2026)

Achieving Total Wellbeing for All, through Targeting Wider Determinants of Health

5 strategic themes focusing on important population segments across life stages with the aim to advance human health and potential in the population, measured by Quintuple Aim

Theme 1 EXPANDED	Theme 2 EXPANDED	Theme 3	Theme 4	Theme 5 NEW
Address gaps in preventive health and early interventions for mothers, children and adolescents	Address gaps in the prevention and management among patients with diabetes and hypertension	Address wider determinants of health and strengthen caregiving ecosystem for patients with complex needs	Address the large pre-frail segment through tracking intrinsic capacity and moving upstream for frailty prevention	Act as a Nexus for ageing research in the community
MATERNAL & CHILD HEALTH + VULNERABLE ADOLESCENTS	**HYPERTENSION + DIABETES**	**COMPLEX NEEDS**	**PRE-FRAILTY & FRAILTY**	**AGEING IN THE COMMUNITY**

5 Core Facilities and Enablers

- **Implementation Science & Evaluation**
- **Data & Financial Analytics**
- **Population Segmentation**
- **Person-Centred Technology**
- **Research Panel & Survey Capabilities**

Expanded group of partners

Healthcare: SGH, SKH, CGH, SHP, SCH, KKH, NDCS, NHCS, NNI, IMH | **Research and IHLs**: Duke-NUS, Duke Durham, NUS, SUTD, SUSS, SIT, GERI

Government: MOHT AIC, URA, MSF, HPB | **Industry** and **community partners**

Overview of CPHRI's Signature Research Programmes

EMPOWER

Lead PI:
A/Prof Low Lian Leng
(SGH, OCH)

Funding: MOH National Innovation Challenge (NIC) Grant, AI.SG Grand Challenge Stage 2, NMRC HCSA ($4.765M)

Key Outcome(s):
- Build on AI engine to deliver **personalized nudges** and **gamification**
- **Sustainable & cost-effective behavioural change** in chronic disease patients

Status:
- Conduct of various RCTs and Commercialisation with private insurer and healthcare

EASE*

Lead PI:
A/Prof Ng Yee Sien
(SKH, SGH)

Funding: URA Cities of Tomorrow R&D Programme ($2.43M)

Key Outcome(s):
- Determine impact of **Environment, Health and Social factors** on Life Spaces in the **Community-Dwelling Elderly**

Policy Impact:
- Policies & urban recommendations that are senior-friendly

SCREENii

Lead PI:
Dr Pua Yong Hao
(SGH)

Funding: National Health Innovation Centre and National Medical Research Council Transition Award ($0.25M)

Key Outcome(s):
- Develop and validate an **automated tool** to enable **feasible and accurate pre-frailty screening** in the community

Status:
- PoC completed. Ongoing prototype refinement and Commercialisation

Project Pensieve

Lead PI:
Dr Liew Tau Ming
(SGH)

Funding: National AI Office (Prime Minister Office) ($1.826M)

Key Outcome(s):
- Develop an **AI-enabled digital tool** for **early detection of dementia**

Policy Impact:
- Transform community screening to be done by lay personnel

INFINITY-ICOPE+

Lead PI:
A/Prof Laura Tay
(SKH)

Funding: MOH NIC Grant Call on Frailty ($3.17M)

Key Outcome(s):
- To maintain **functional independence** in older adults, represented by life-space mobility reflecting their community participation
- To **implement INFINITY-ICOPE with high fidelity, penetration and sustainability** within the community

Build & Care

Lead PI:
A/Prof Low Lian Leng
(SGH, OCH)

Requesting *NMRC PHRG Funding with support from MND*

Key Outcome(s):
- To **intervene in environmental & social determinants** to support healthy ageing and assisted living

Policy Impact:
- Understand the trajectory of ageing and health
- guide policy on HDB built architecture and quantity

Please refer to annex (slides 22-26) for more details

*EASE: The Elderly Life Activity-Space Project
+INFINITY-ICOPE - Optimising INtrinsic Capacity for Functional INdependence and to Impede FrailTY in Older Adults: Adaptation of the WHO-ICOPE for Healthy Ageing in Singapore

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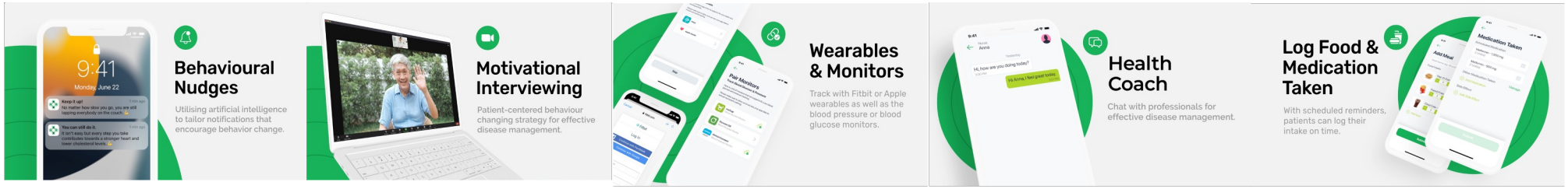
EMPOWER

Lead PI: A/Prof Low Lian Leng

Funding: MOH National Innovation Challenge Grant, AI.SG Grand Challenge Stage 2, NMRC HCSA



- Build on AI engine to deliver **personalized nudges** and **gamification**
- Sustainable & cost-effective behavioural change in chronic disease patients
- Current status: successfully completed trials among 1000 DM patients

In collaboration with:

NUS National University of Singapore – Saw Swee Hock School of Public Health

NUS National University of Singapore – School of Computing

SingHealth DukeNUS Academic Medical Centre – Diabetes Centre

National Heart Centre Singapore, SingHealth

Polyclinics, SingHealth

DukeNUS Medical School

Ministry of Health Singapore

Health Promotion Board

Nanyang Technological University Singapore

Key Plans in the next 3 Years

- Complete trial among patients with Diabetes, Hypertension and Hyperlipidemia **(Jarvis-EMPOWER)**
- Text effectiveness of App-based and Health Coach delivered Motivational Interviewing **(EMPOWER – PLUS)**
- Seek **commercialisation** opportunities:
  - Private healthcare and insurer are interested in commercialising AI modules and algorithms
- **Scaling up** through HealthBuddy

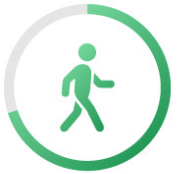
SingHealth

EMPOWER

Tapping on Complementary Strengths

NUS National University of Singapore
School of Computing

- App development
- AI & Machine learning for nudges
- Predictive modelling



74.7%
in predicting if a user will reach 4,000 steps for a given day
Median accuracy: 77.9%

86.8%
in predicting if a user will enter an activity log for a given day
Median accuracy: 96.7%

83.5%
in predicting if a user will reach 150 mins of MVPA for 2 consecutive weeks
Median accuracy: 86.7%

DukeNUS Medical School

- Expertise in qualitative research, implementation science

89.9%
in predicting if a user will enter an activity log for 3 consecutive days
Median accuracy: 100%

85%
in predicting if a user will reach 30 mins of MVPA for a given day
Median accuracy: 92.9%

The ANN model is accurate in predicting users' behaviors and can deliver personalized nudges.

Duke Psychiatry & Behavioral Sciences
Duke University School of Medicine

- Expertise in Behavioural science
- Expertise in motivational interviewing

The Elderly Life Activity-Space Project (EASE)

The Environmental, Health and Social Factors Determining Seniors' Life Spaces in the Community

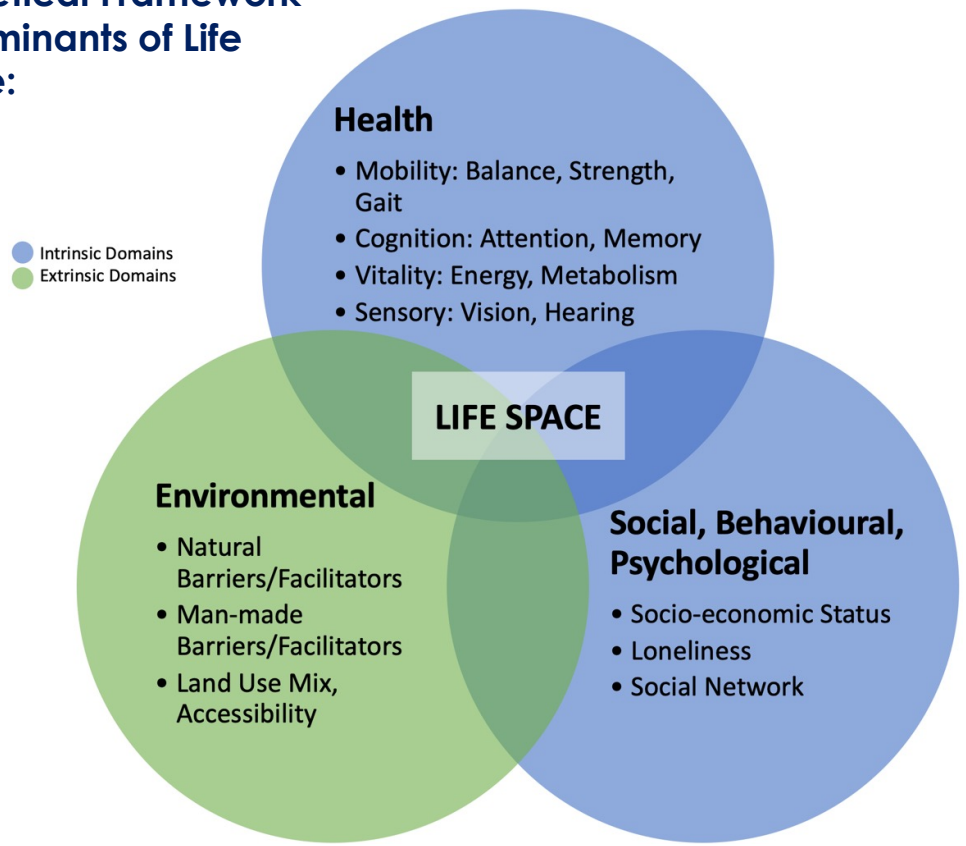
Lead PI: A/Prof Ng Yee Sien

Funding: URA Cities of Tomorrow Grant

Life Space: The area through which a person moves, over a specified time period, through his community and its environment, to achieve life-goals of self-care, employment, social and recreational needs

- Has significant **health consequences** if not maintained
- Limited research conducted in Asia

Theoretical Framework Determinants of Life Space:



Robust Empirical Research Approach:

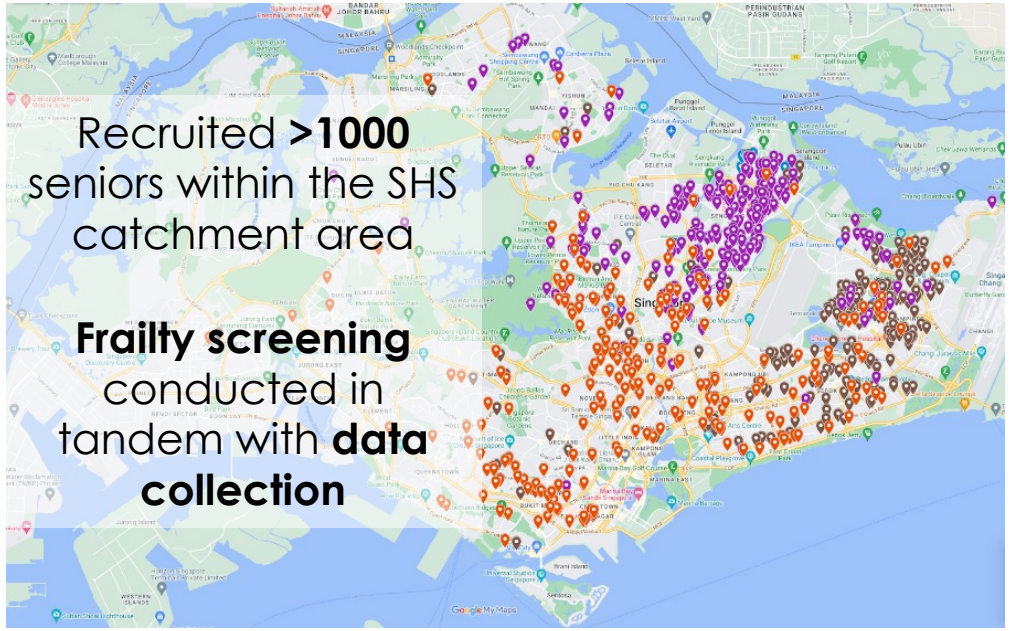
Objective measures:
- Geospatial data tracked by app
- Physical performance tests

Data on **Life Space & Determinants**

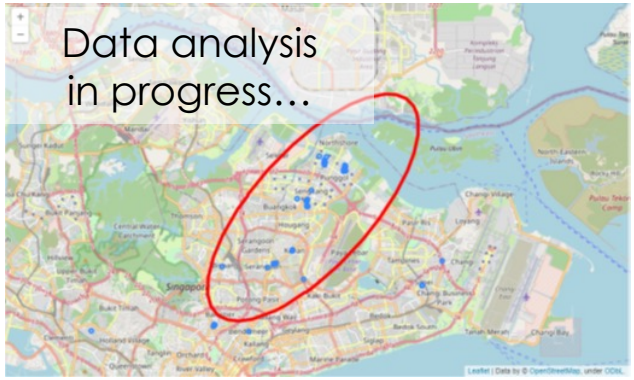
Self-Report measures:
- Comprehensive questionnaire

Interviews:
- Semi-structured
- Go-along

Progress and Plans



1. Data collection will continue for more robust data → recruitment target upped from 900 to **1300**

2. 

Triangulation of data → Holistic knowledge of local seniors' life spaces & their determinants

3. Data-driven **policy proposals & urban recommendations t**hat are senior-friendly

Participant filling out the study questionnaire

Measuring muscle mass with a bioelectrical impedance analyzer

Measuring blood pressure

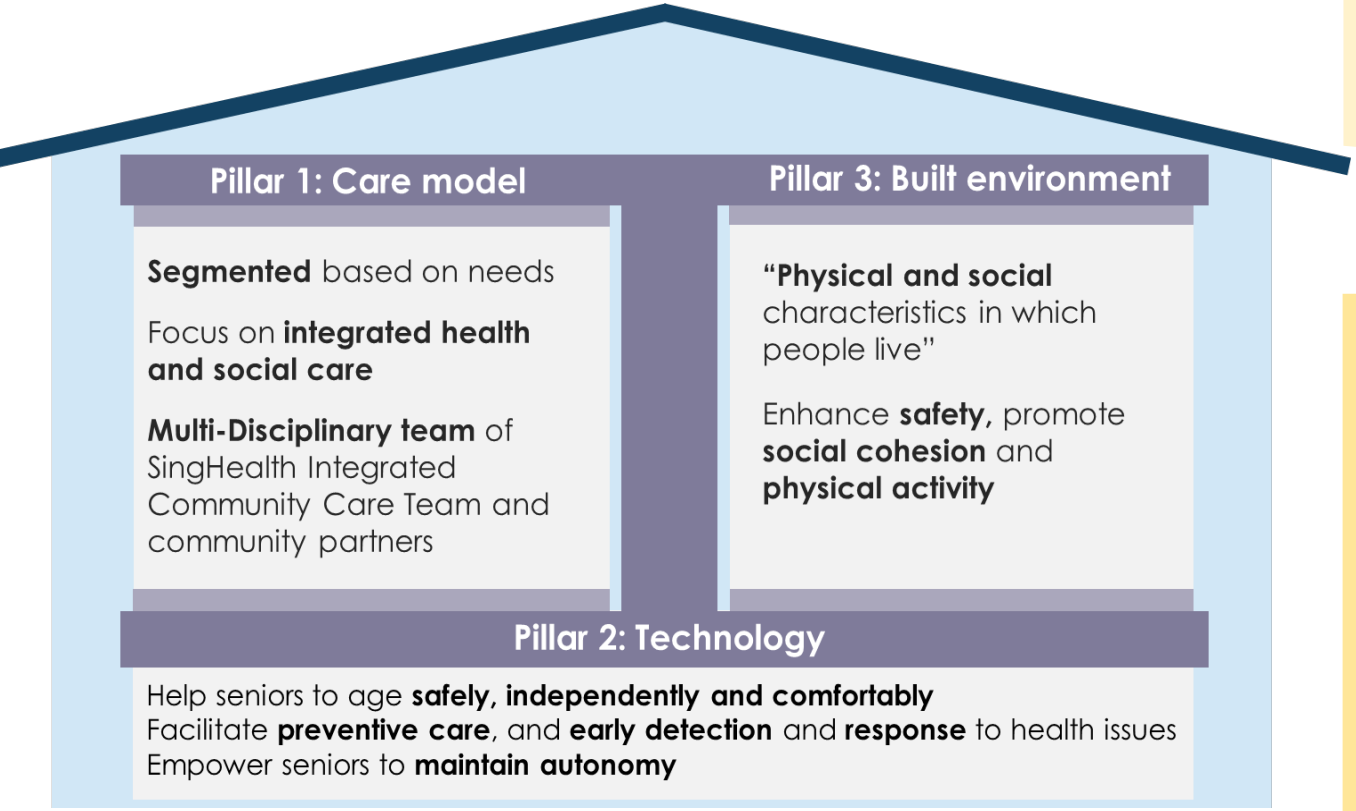
Multi-disciplinary and Multi-sectorial Collaboration

Government/Advisory Partners	Academic/Industry Partners	Community Partners
- Provide **advice on research questions which addresses unmet needs and issues** that matter	- **Qualitative** expertise - **Geriatric** expertise - **Urban design** expertise - **Geospatial analysis** expertise - **Data collection app**	- Assist with **outreach, publicity & recruitment** - Share **accessible community spaces for data collection**

Innovate & Co-create a Community Ageing-in-Place Ecosystem

@ Marine Parade & Bedok Brownfield sites

intervene in environmental & social determinants to support healthy ageing and assisted living



Hypothesis:

Built environment interventions and technology will enhance the **integrated health and social care** programs' capabilities to support healthy ageing and assisted living

What we will study

Hybrid implementation - effectiveness
Guide the deliberate implementation strategies of "common elements" by anticipating/ addressing barriers and facilitating adoption

Built Environment health/well-being framework
Study the causation between built environment and health at the neighbourhood/ precinct level

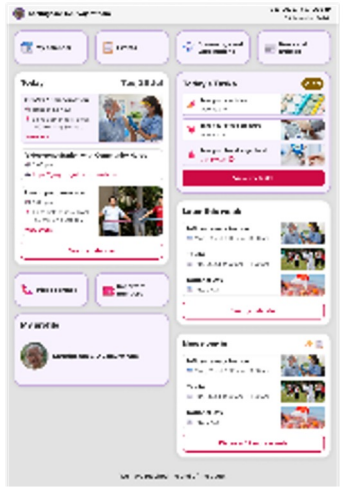
Understand the **trajectory of ageing and health → guide policy on HDB built architecture and quantity**

Requesting NMRC PHRG funding from MOH. Supported by MND

Multi-level Interventions to Address Environmental and Social Determinants

Residential Level Interventions

Technology projects/systems to allow convenient access to readily available help, self-monitoring of health and conditions, improve safety and reduce caregiving burden



Personal Assisted Living Solutions Senior Concierge

Sensei (Docking Station with Blood Pressure Machine)

Non-Invasive Radar Monitoring System

PwDementia Location Tracker

Repurposing Level Interventions

Adaptive use of HDB units to facilitate easy-to-access care, social interaction, physical and cognitive activities

Community Kitchen unit

Day Care Centre unit

Rehabilitation Services unit

Interactive IT unit

Neighbourhood Level interventions

Wayfinding cues & graphic signs

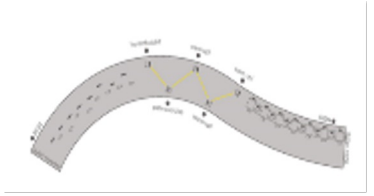
Aesthetic sound

Community gardens

Inclusive social spaces

Memory building features

Active Health Fitness Trail



Agility paths

Attractive staircase design

Collaborative Partnerships Across Sectors

Built Environment

- Provide recommendations to align with **national needs and interest**
- **Expertise in urban design**
- Retrofitting, built environment modifications

Technology

- Provide and co-test **senior-friendly technological products & systems**

Care Models

- Offer **health & social services & programmes** in the community
- Facilitate **trials and recruitment** of participants
- **Care needs analysis**

Collaboration with Institutes of Higher Learning

- Tapping on Complementary Strengths

SINGAPORE INSTITUTE OF TECHNOLOGY

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

STRENGTHS

- Digital & Sensor Technology
- Translational Innovations & Technology Adoption
- Industry Network & Partnership
- Food Science & Technology
- Built Environment & Design
- Geospatial Analysis

AREAS OF COLLABORATION

- Light weight and breathable **wearables** for seniors
- **Solutioning for implementation challenges** e.g. using thermal cameras to monitor movements of patients
- Protein-enriched **food for seniors**
- **Gamification** for heathy food options and healthy eating

Joyful Village Project @ Jalan Pelatok Park (collaboration with SUTD)

- **Evaluation** of Built Environment with health
- Environmental-evolutionary psychological ideas for designing the living environment to make it more **psychologically-conducive for elderly**
- Addressing **environmental, health and social determinants to improve seniors' Life Spaces** in the community
- SingHealth-SUTD **Population Health Innovation Fund Joint Grants**

Collaborations with Institutes of Higher Learning

- Tapping on Complementary Strengths

DukeNUS Medical School

Department of Population Health Sciences
Duke University School of Medicine

SUSS
SINGAPORE UNIVERSITY OF SOCIAL SCIENCES

STRENGTHS

- Mixed-method Research
- Implementation Science & Evaluation
- Behavioural & Social Sciences
- Health Economics & Impact Analysis
- Ageing Research

AREAS OF COLLABORATION

- **Capability building and bridge the Knowledge-Do gaps**
- **Community of Practice** of Implementation Science
- **Community engagement & qualitative research**
- Validation and application of **social profiling** tools among seniors
- Co-design **nudge mechanism** for behavioural interventions
- **Evaluation of Primary Care Enrolment**
- Co-validation of **evaluation toolkit**
- **Caregiving** needs assessment and interventions
- **Social Prescribing** research and capability building in the community

Growing Impact of Population Health Research

Harmonized Population Segmentation Framework with NUHS & HPB

Healthy and Non-Healthcare Utilisers			Healthy with Outpatient Utilization			Healthy with Inpatient Admission			Low Complex Chronic Conditions	Medium Complex Chronic Conditions	Frail in the Community	Mental Health Condition	High Complex Chronic Conditions	Frail in Community with High Complex	Cancer	Frail in Care (Residential Care)	End of Life
Healthy Non-User - With no known condition and neither clinical nor social risk factors*	With one or more clinical and/or social risk factors*		With non-chronic conditions, but with ≥1 polyclinic or SOC visits and no inpatient admissions			With non-chronic conditions, but with ≥1 inpatient admissions			Diabetes; Hypertension; Osteoporosis; Osteoarthritis; Asthma; Epilepsy; Hyperthyroidism; Hypothyroidism; BPH; Lipid disorder; Episodic Depression	Angina; COPD; Pre dialysis CKD; CHD; Rheumatoid Arthritis; Parkinsons; Moderate Liver Disease; PVD	Require home and community center services (except for palliative home services)	With mental health condition(s)	Dementia; Heart Failure; Kidney Transplant; Severe Liver Disease;	In both Frail in Community and High Complex Chronic Conditions groups	Cancer; Metastatic Cancer	Utilise services in nursing homes and chronic sick hospitals	Utilise home palliative or inpatient hospice services
	At Risk Children & Adults with no known condition [0 -64 years]	At Risk Seniors with no known condition [65 years & above]	Child & Youth [18 years and below]	Adults [19 - 64 years]	Seniors [65 years and above]	Child & Youth [18 years and below]	Adults [19 - 64 years]	Seniors [65 years and above]									
In Registry for this Combination																	
										Osteoporosis & Spine Fracture; Osteoporosis & Hip Fracture; Diabetes & Depression; Hypertension & Osteoarthritis; Hypertension & Osteoporosis; Osteoarthriti & Osteoporosis; Rheumatoid Arthritis & Osteoporosis			Angina & COPD; AMI & Pre-dialysis CKD; Diabetes, Hypertension & Osteoarthritis;				
Had this Event or Intervention																	
										Coronary Artery Bypass Graft (CABG); AMI (Heart Attack); PCI; LEA			Stroke; CKD on Dialysis				

Joint Resident Profiling & Segmentation with HPB and NUHS

- **Sociodemographic**
- **EISS screening data**
- **RHS clinical data**
- **National Step Challenge**

Overall, 12k improved their diabetes management under NSC

AI4HealthyCities Singapore: Harnessing the Power of Data to Improve Cardiovascular Health Outcomes and Equity

Multi-agency and cross-cluster effort, in collaboration with Novartis Foundation (AI for Health Cities)

Building on **national and cluster databases**:

- National Diabetes Database
- SingCLOUD
- MOH Omnibus
- HPB National Step Challenge
- MOH TRUST Platform

NOVARTIS | The Novartis Foundation

MINISTRY OF HEALTH SINGAPORE

Health Promotion Board

SingHealth Defining Tomorrow's Medicine

NUHS National University Health System

National Healthcare Group

Summary

- **Inter-disciplinary**, **multi-sectoral** and **whole of system** approach for population health research is key to achieve greater societal impact

- Leverage **complimentary strengths** to build population health research capabilities

- Further strengthen '**public-private' partnerships** for innovative solutions to improve population health outcomes

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Thank You & Acknowledgements to all our CPHRI team and partners

low.lian.leng@singhealth.com.sg