Person-Centered Integration of ICOPE Framework and Smart Technologies for Healthy Longevity

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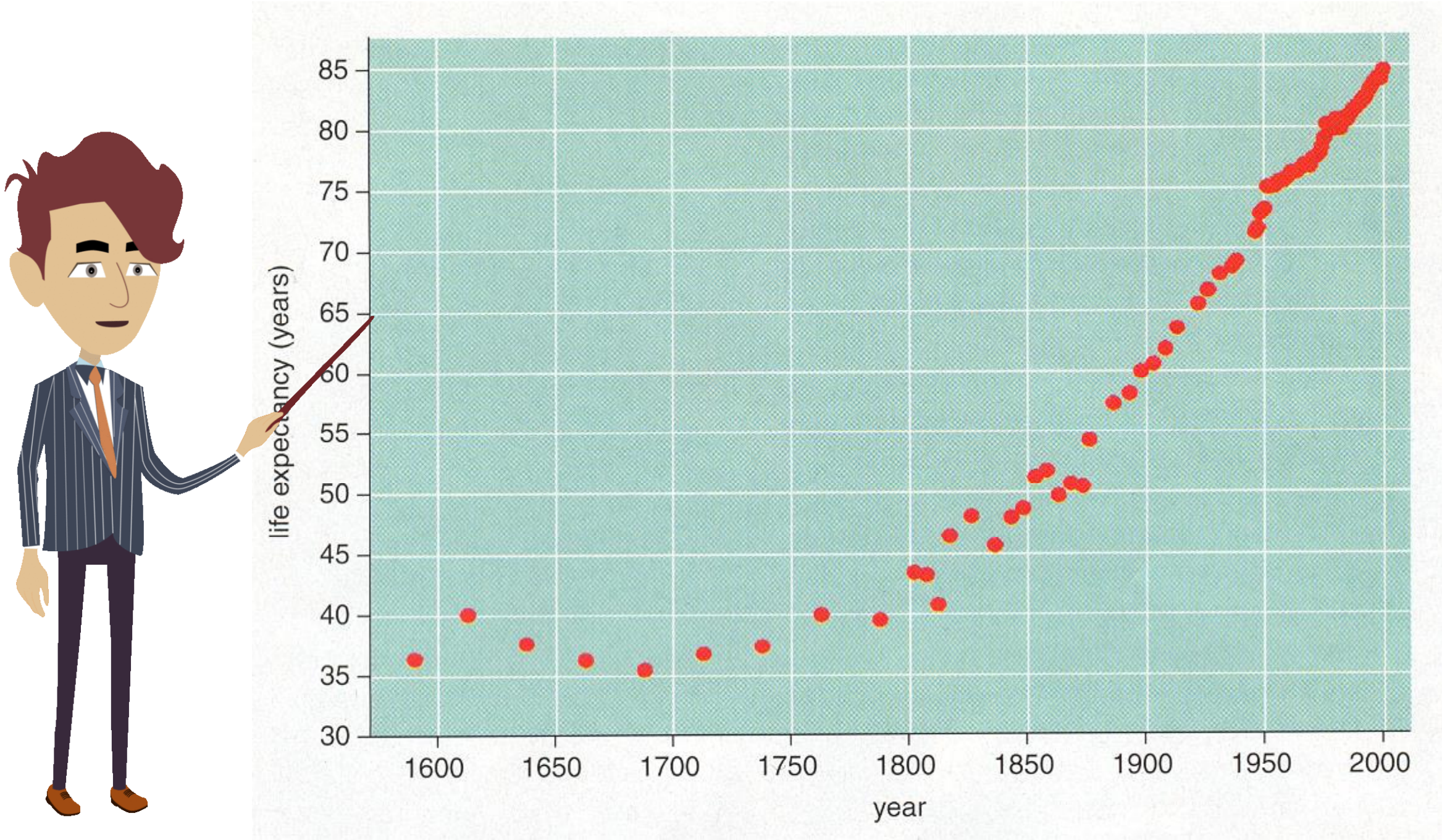
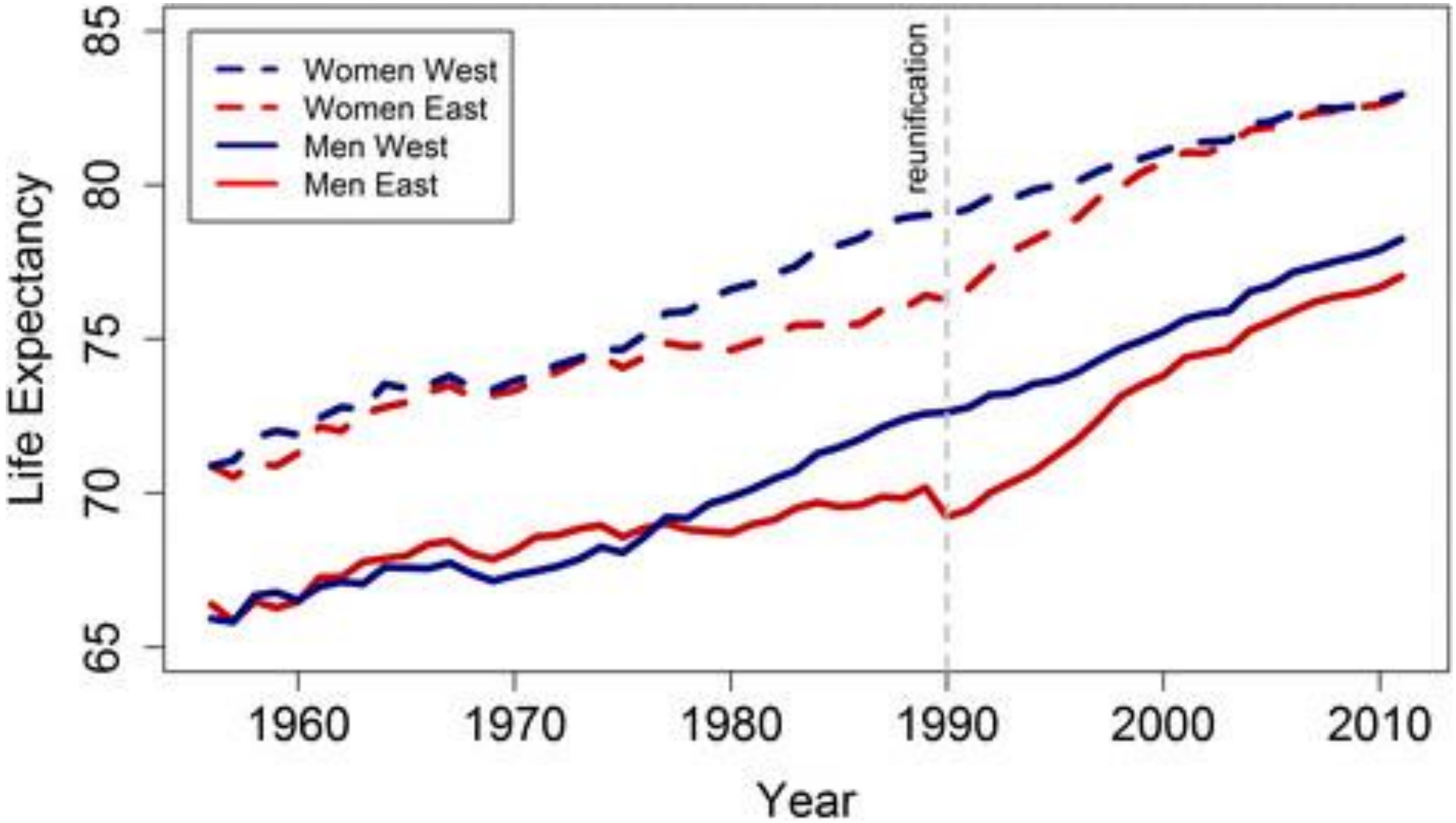
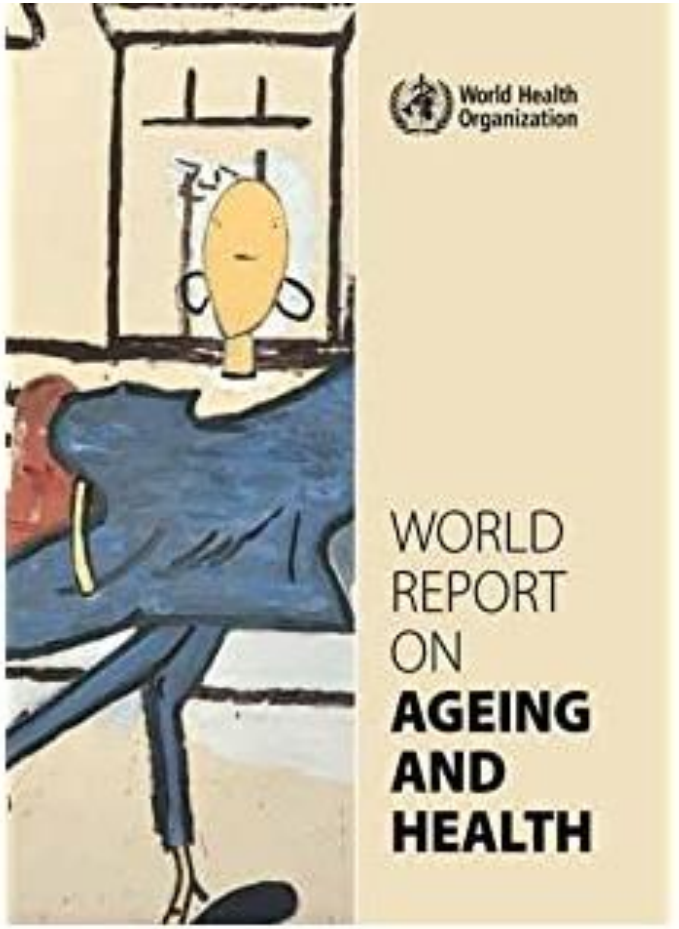
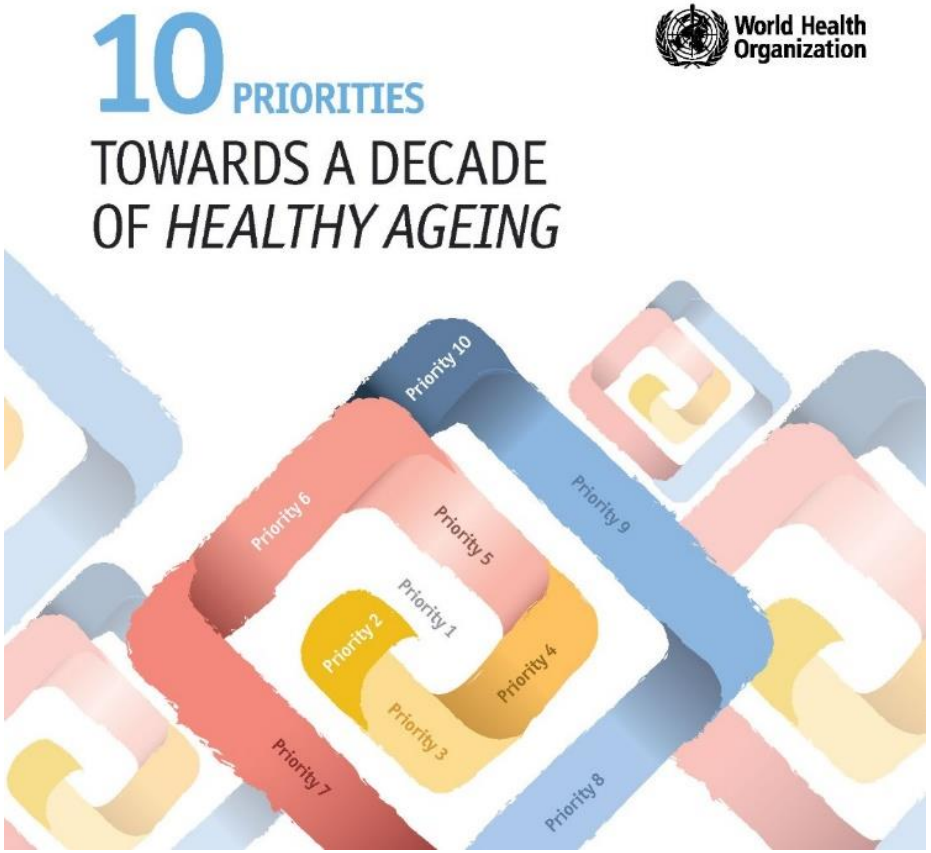
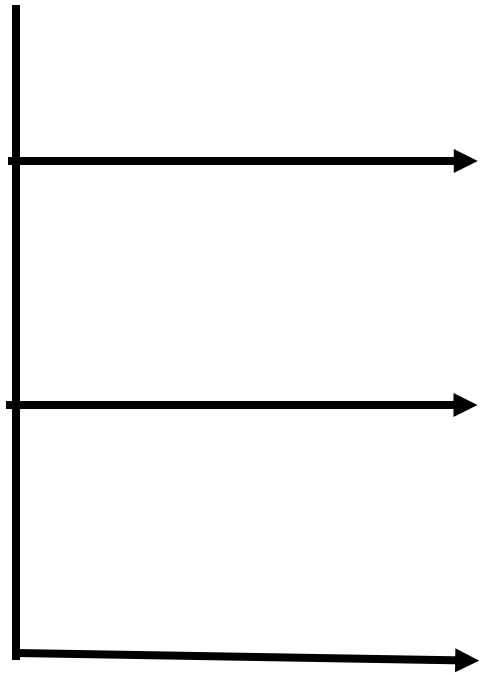

life expectancy (years)
85
80
75
70
65
60
55
50
45
40
35
30
1600
1650
1700
1750
1800
1850
1900
1950
2000
year

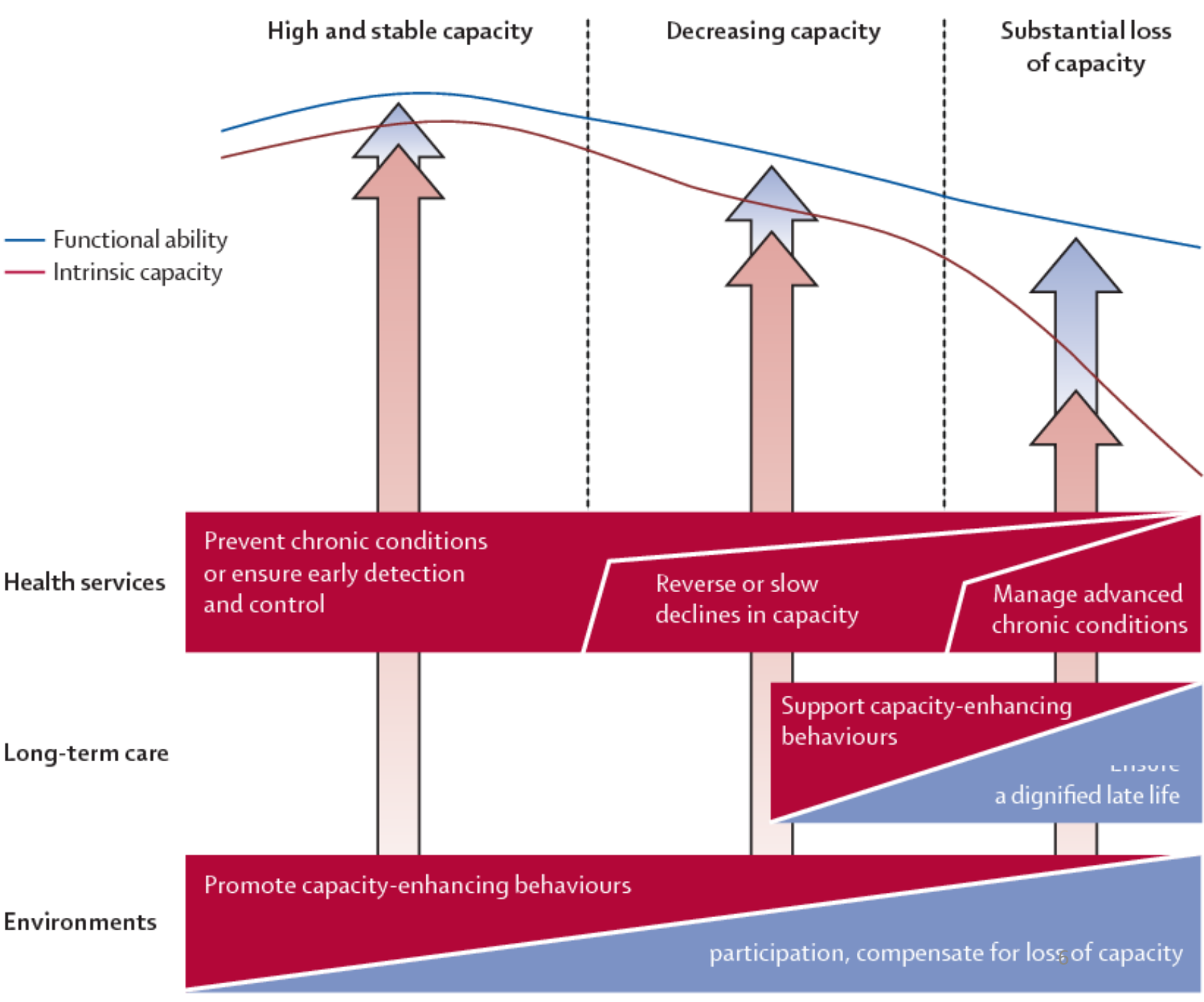

Women West
Women East
Men West
Men East
reunification
Life Expectancy
65
70
75
80
85
1960
1970
1980
1990
2000
2010
Year

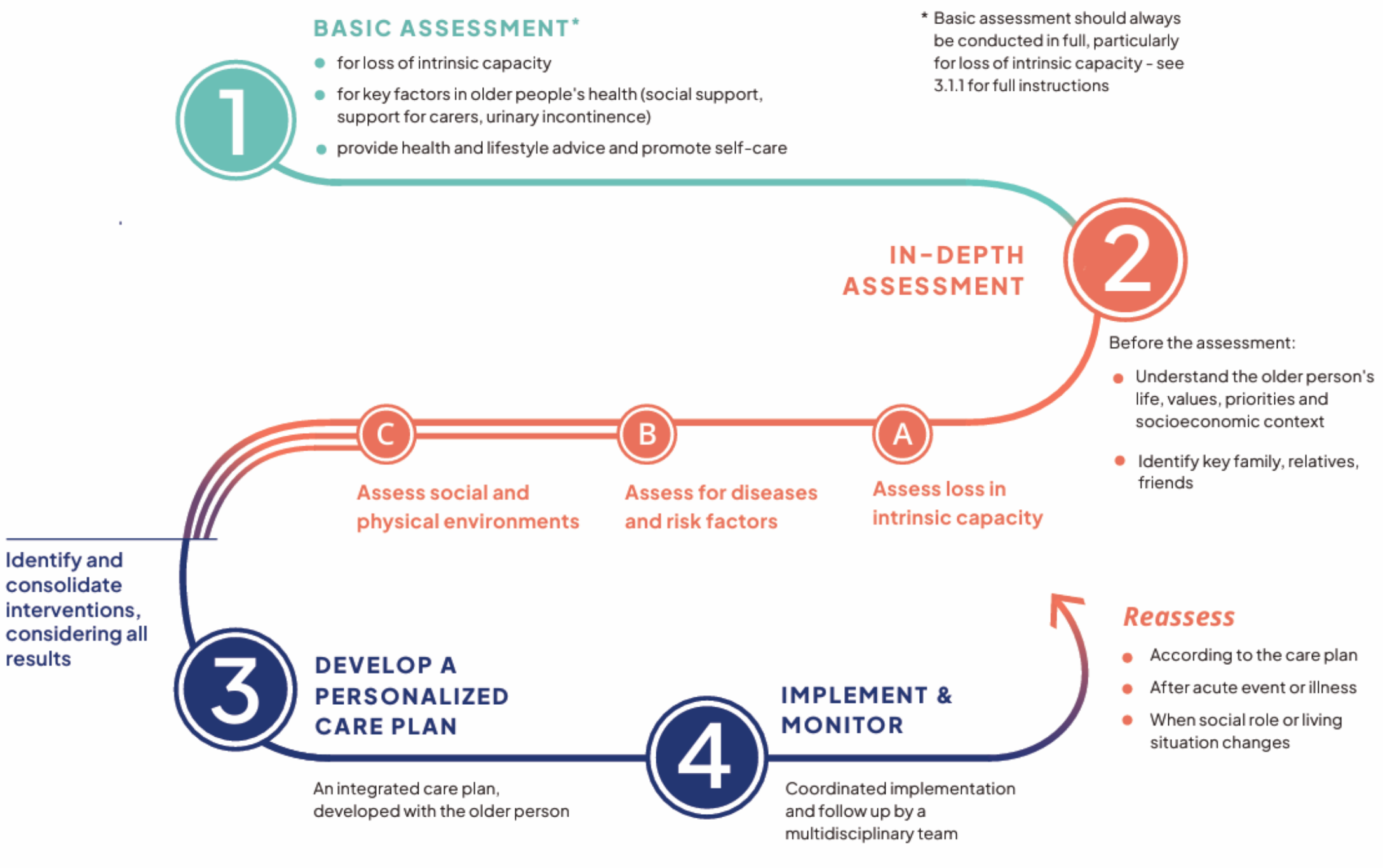
Global Plans for Healthy Aging







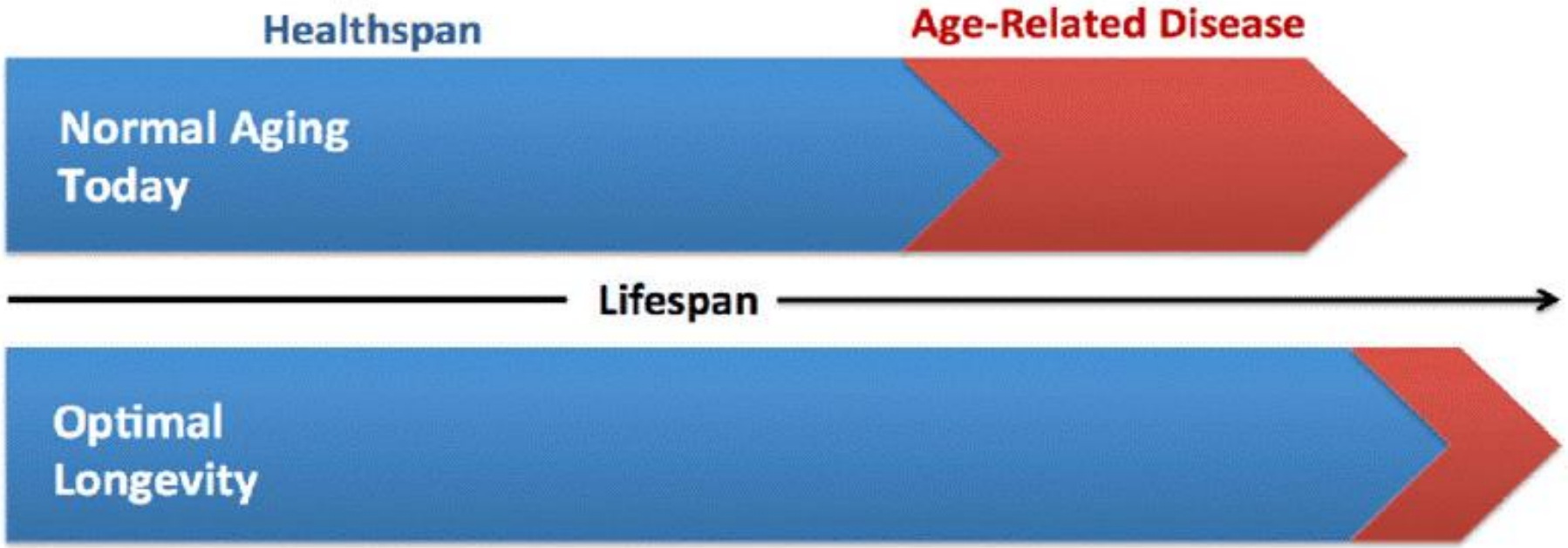

High and stable capacity
Decreasing capacity
Substantial loss of capacity
Functional ability
Intrinsic capacity
Health services
Long-term care
Environments
Prevent chronic conditions or ensure early detection and control
Reverse or slow declines in capacity
Manage advanced chronic conditions
Support capacity-enhancing behaviours
a dignified late life
Promote capacity-enhancing behaviours
participation, compensate for loss of capacity


BASIC ASSESSMENT*
for loss of intrinsic capacity
for key factors in older people's health (social support, support for carers, urinary incontinence)
provide health and lifestyle advice and promote self-care
1
* Basic assessment should always be conducted in full, particularly for loss of intrinsic capacity - see 3.1.1 for full instructions
IN-DEPTH ASSESSMENT
2
Before the assessment:
Understand the older person's life, values, priorities and socioeconomic context
Identify key family, relatives, friends
A
Assess loss in intrinsic capacity
B
Assess for diseases and risk factors
C
Assess social and physical environments
Identify and consolidate interventions, considering all results
3
DEVELOP A PERSONALIZED CARE PLAN
An integrated care plan, developed with the older person
4
IMPLEMENT & MONITOR
Coordinated implementation and follow up by a multidisciplinary team
Reassess
According to the care plan
After acute event or illness
When social role or living situation changes

Health for ALL and LONGER

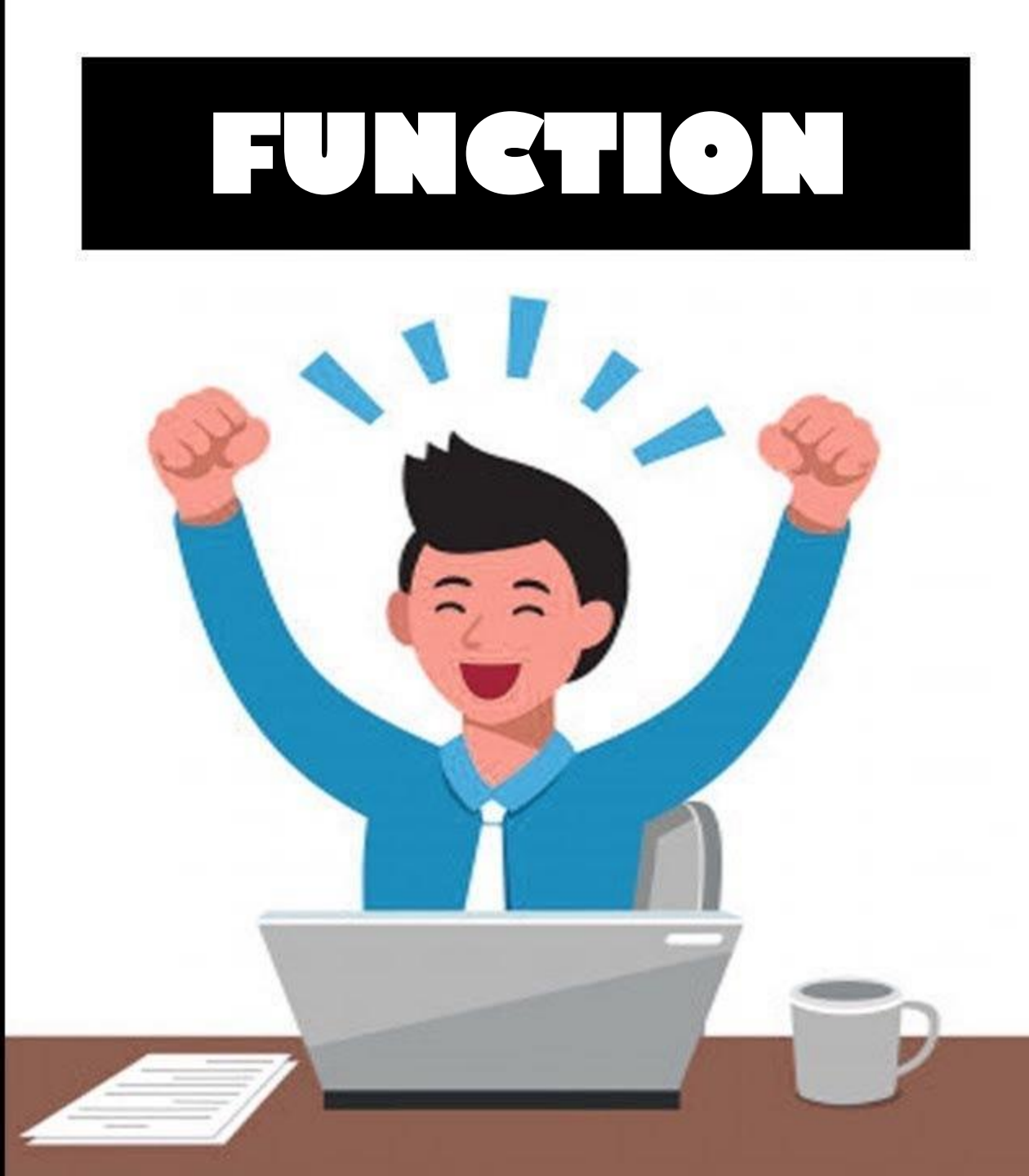
Healthy Aging
Healthy Longevity

A process of developing and maintaining functional ability to ensure late-life wellbeing



DISEASE

FUNCTION



The Economist

Ward beds: 179

Wards (112)

- Acute: 45
- Chronic: 67

Specials (67)

- ED beds 3
- ICU: 3
- Dialysis: 19
- RCW: 32
- Palliative: 10

Long-Term Care (142)

- Day beds: 50
- Nursing beds: 92

Total beds: 321

關渡（Gan-Dau）

關渡地名由凱達格蘭族地名「Kantou」而來，西班牙文獻則寫作「Casidor」。因而關渡有多個諧音的地名，例如：甘答、干豆、官渡等，均是平埔族語的譯音。乾隆二十五年《臺灣府誌》稱「關渡」，日治時代稱為「江頭」，光復後恢復使用「關渡」。

Fishery

Farming

Youngsters

Seniors

Technology

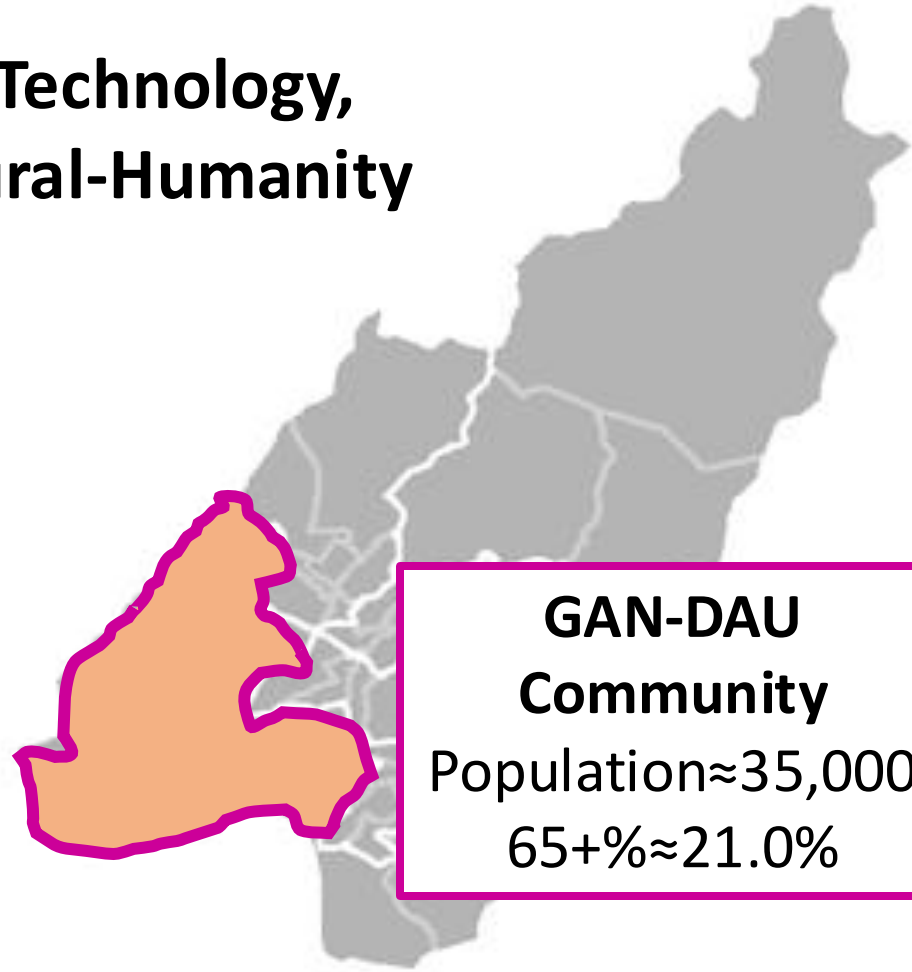
Religion

Humanity

Urban-Rural, Tradition-Technology, Youngsters-Seniors, Cultural-Humanity

臺北市立關渡醫院
TAIPEI MUNICIPAL GAN-DAU HOSPITAL

TVGH Operates GDH for over 20 years

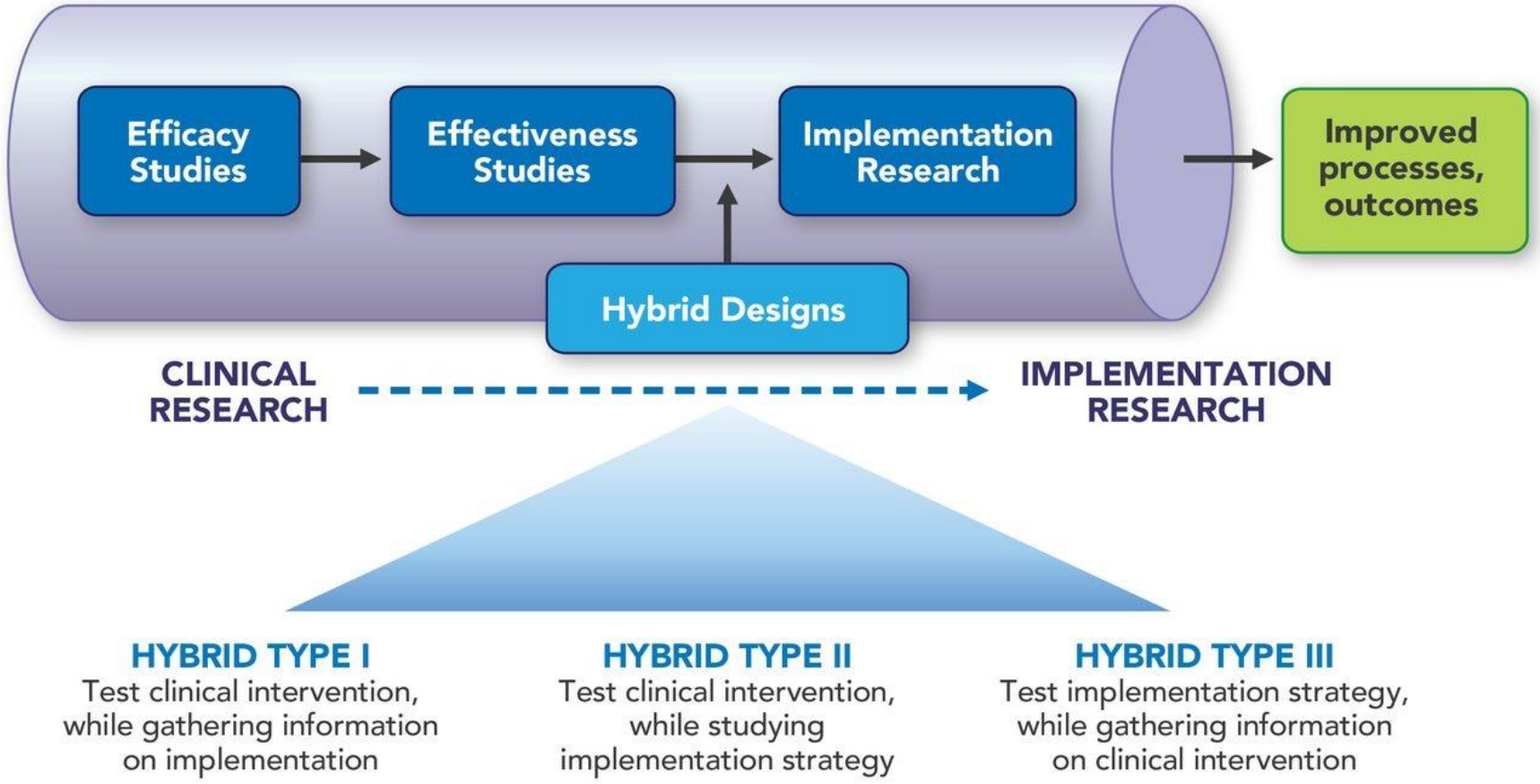


GAN-DAU Community
Population≈35,000
65+%≈21.0%

Hybrid Model of Implementation Research

Smoking rate
21.9% (2008)

Intrinsic capacity
Disability-free survival, Value-based metrics (2021)

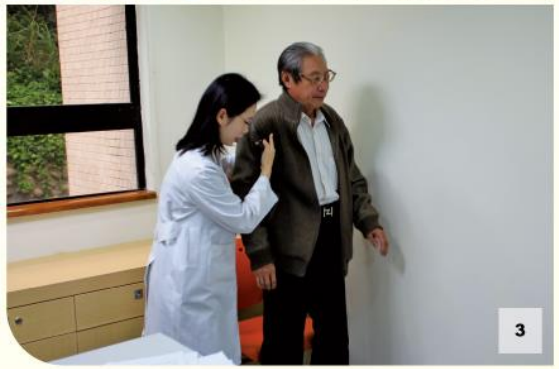


Smoking rate
13.1% (2020)

Intrinsic capacity
Disability-free survival, Value-based metrics (2023)

門診流程

高齡醫學整合門診目前每週開設四診，每診以診治15位病患為原則。每個診次二到四位醫師與一位個案管理師，共同為患者進行看診。



1.基本資料登錄
護理人員針對初次就診的老年患者，詢問基本資料及護理評估。

2.完整病史詢問
資深住院醫師：針對老年患者進行初步身體檢查，並且了解過去的完整病史。

3.周全性老年評估
個案管理師：透過測驗，評估老年患者於日常生活的自主能力。

4.整合醫療診斷
老年醫學次專科醫師、復健科與精神科醫師：進行整合醫療評估。

5.完成門診流程，僅以一次計價。

Integrated Outpatient

Quality
49.8%

Expenditure
35.4%

Tao P, et al., Geriatr Gerontol Int 2012;12:612-21

環境與設施

1.復健治療區
附設簡易復健室，便於患者就近復健。

2.開放式沐浴間
開放式設計，便於病床直接推入，並備有造價百萬的漩渦式超音波沐浴機，便於協助失能患者沐浴盥洗。

3.走道高低扶手設計
便於拐杖、輪椅等輔具使用者，皆可扶撐前進。

護理站之櫃檯親善設計
讓使用輪椅的患者，可方便於護理站諮詢。

Geriatric Acute Units

Independence
32.5%

Mortality
76.2%

Hsu CC, et al., Aging Med Healthc 2021;12:62-67

Post-Acute Care

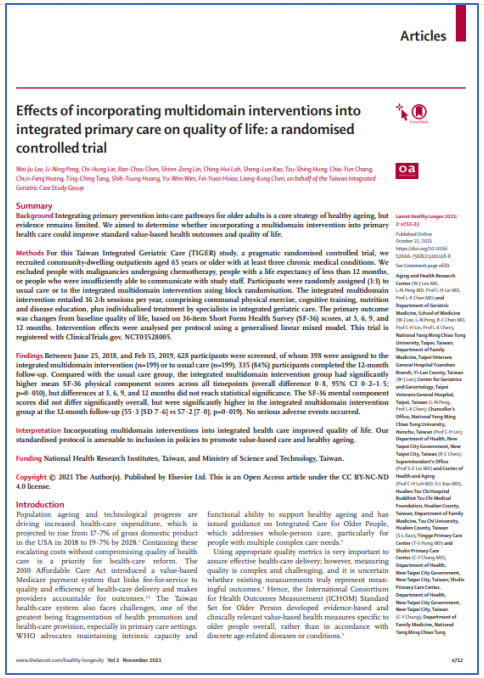
Independence
48.6%

Mortality
62.0%

Chen LK, et al. Ann Med 2010;42:630-6

連結整合醫療、安養、服務機構功能以及資源，建構榮民健康促進及長期照護制度，使榮民（眷）獲得妥善「全人、全程、全家」的醫療照護。

以榮總為核心，建構榮總、榮院及榮家保健組之「三級醫療」垂直支援與轉診制度。
配合榮院水平、垂直整合作法，結合榮家人力、設施，建置門診、復健及長期照護（護理之家）資源。



Articles

Effects of incorporating multidomain interventions into integrated primary care on quality of life: a randomised controlled trial

Wei-Ju Lee, Li-Ning Peng, Chi-Hung Lin, Ran-Chou Chen, Shinn-Zong Lin, Ching-Hui Loh, Sheng-Lun Kao, Tzu-Shing Hung, Chia-Yun Chang, Chun-Feng Huang, Ting-Ching Tang, Shih-Tsung Huang, Yu-Wen Wen, Fei-Yuan Hsiao, Liang-Kung Chen, on behalf of the Taiwan Integrated Geriatric Care Study Group

Summary

Background Integrating primary prevention into care pathways for older adults is a core strategy of healthy ageing, but evidence remains limited. We aimed to determine whether incorporating a multidomain intervention into primary health care could improve standard value-based health outcomes and quality of life.

Methods For this Taiwan Integrated Geriatric Care (TIGER) study, a pragmatic randomised controlled trial, we recruited community-dwelling outpatients aged 65 years or older with at least three chronic medical conditions. We excluded people with malignancies undergoing chemotherapy, people with a life expectancy of less than 12 months, or people who were insufficiently able to communicate with study staff. Participants were randomly assigned (1:1) to usual care or to the integrated multidomain intervention using block randomisation. The integrated multidomain intervention entailed 16 2-h sessions per year, comprising communal physical exercise, cognitive training, nutrition and disease education, plus individualised treatment by specialists in integrated geriatric care. The primary outcome was changes from baseline quality of life, based on 36-item Short Form Health Survey (SF-36) scores, at 3, 6, 9, and 12 months. Intervention effects were analysed per protocol using a generalised linear mixed model. This trial is registered with ClinicalTrials.gov, NCT03528005.

Findings Between June 25, 2018, and Feb 15, 2019, 628 participants were screened, of whom 398 were assigned to the integrated multidomain intervention (n=199) or to usual care (n=199). 335 (84%) participants completed the 12-month follow-up. Compared with the usual care group, the integrated multidomain intervention group had significantly higher mean SF-36 physical component scores across all timepoints (overall difference 0·8, 95% CI 0·2–1·5; p=0·010), but differences at 3, 6, 9, and 12 months did not reach statistical significance. The SF-36 mental component scores did not differ significantly overall, but were significantly higher in the integrated multidomain intervention group at the 12-month follow-up (55·3 [SD 7·6] vs 57·2 [7·9]; p=0·019). No serious adverse events occurred.

Interpretation Incorporating multidomain interventions into integrated health care improved quality of life. Our standardised protocol is amenable to inclusion in policies to promote value-based care and healthy ageing.

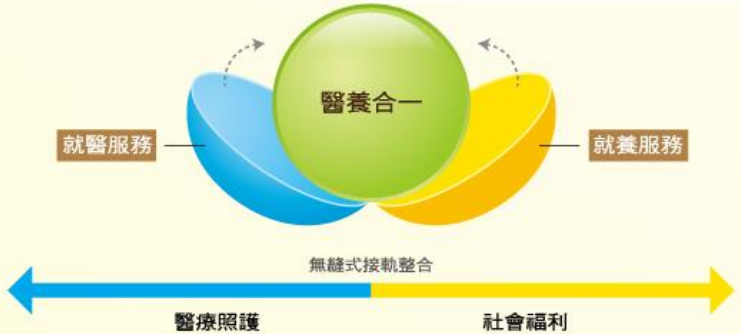
Funding National Health Research Institutes, Taiwan, and Ministry of Science and Technology, Taiwan.

Introduction

Population ageing and technological progress are driving increased health-care expenditure, which is projected to rise from 17·7% of gross domestic product in the USA in 2018 to 19·7% by 2028.[1] Containing these escalating costs without compromising quality of health care is a priority for health-care reform. The 2010 Affordable Care Act introduced a value-based Medicare payment system that links fee-for-service to quality and efficiency of health-care delivery and makes providers accountable for outcomes.[2] The Taiwan health-care system also faces challenges, one of the greatest being fragmentation of health promotion and health-care provision, especially in primary care settings. WHO advocates maintaining intrinsic capacity and functional ability to support healthy ageing and has issued guidance on Integrated Care for Older People, which addresses whole-person care, particularly for people with multiple complex care needs.[3]

Using appropriate quality metrics is very important to assure effective health-care delivery; however, measuring quality is complex and challenging, and it is uncertain whether existing measurements truly represent meaningful outcomes.[4] Hence, the International Consortium for Health Outcomes Measurement (ICHOM) Standard Set for Older Person developed evidence-based and clinically relevant value-based health measures specific to older people overall, rather than in accordance with discrete age-related diseases or conditions.[5]

www.thelancet.com/healthy-longevity Vol 2 November 2021

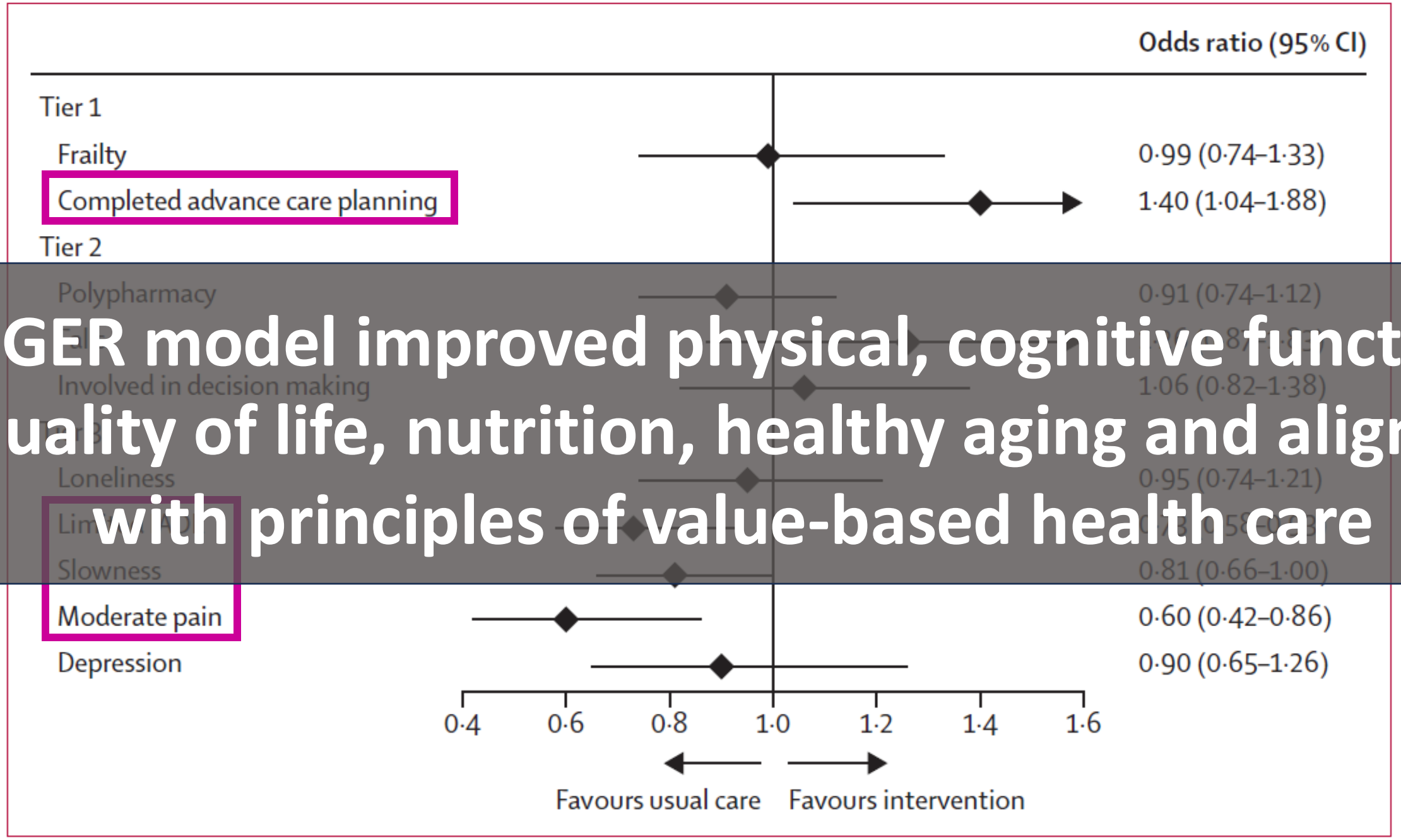


Community Program

Quality of Life 20.0%

Dementia Risk 50.0%

Lee WJ, et al. Lancet Healthy Longev. 2021;2:e712-e723.



TIGER model improved physical, cognitive function, quality of life, nutrition, healthy aging and aligned with principles of value-based health care

Community Resource Integration

51 Community centers

630 Volunteers

46 Community medical clinics

32 Neighborhood security teams

198 NGOs

13 Volunteer teams

2,662 NGO members

3 Artistic groups

Community Activities Are Well Operated But Relatively Lack Strong Scientific Evidence

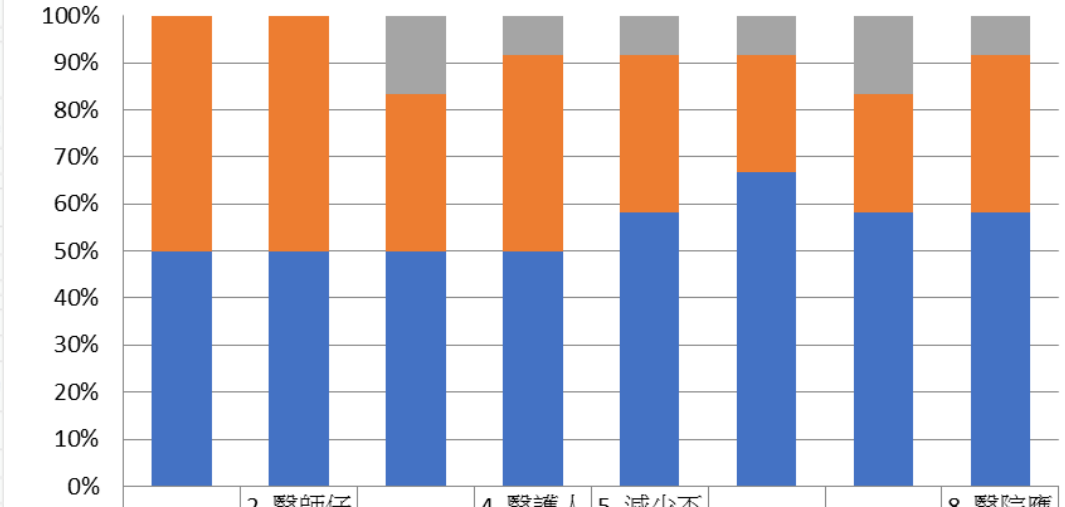
Integrated Outpatient Services

5 specialties

15 physicians

25 sessions/week

23,054 person-visits



	1. 醫師耐心傾聽我的病情	2. 醫師仔細診察及詳細說明病情	3. 醫護人員尊重我的隱私	4. 醫護人員詳細說明看病的程序	5. 減少不同科別間看診有幫助	6. 減少看病次數有幫助	7. 減少用藥數量有幫助	8. 醫院應繼續推動「整合門診」
沒意見			16.70%	8.30%	8.30%	8.30%	16.70%	8.30%
同意	50%	50%	33%	41.70%	33.30%	25%	25%	33.30%
非常滿意	50%	50%	50%	50%	58.30%	66.70%	58.30%	58.30%

Post-Acute Care Services

179 cases

10 Traumatic brain injury

45 Frail older adults

55 Stroke

69 Fragility fractures

▶

>90% functional improvement

包含

Barth index	GDS-5	EQ-5D
IADL	CAM	MRS
CFS	2015 Beer's criteria	BI
SPMSQ	MNA	FOIS

119 (66%) receives home-based PT

90% Returned home

Connecting Home LTC Services

Discharge plan: **564** cases

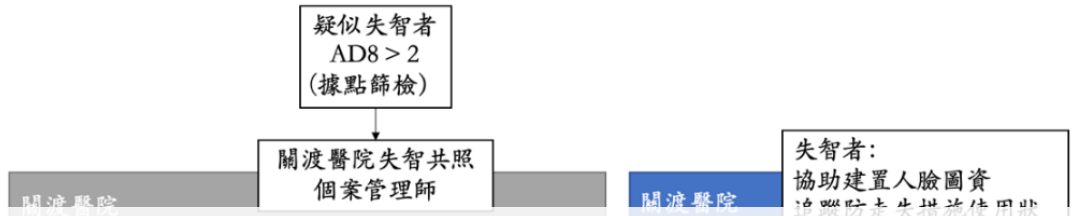
Case management: **7,095** cases

Home Medical: **1,072** visits

Home Nursing: **3,415** visits

Remote Care: **1,976** calls

Community Dementia Care Network



2018-2022

MMSE in MCI cases **IMPROVED 0.7**

Family care burden **REDUCED 16%**

861 case in the network

4,862 counseling visits

4,133 brain health visits

161 community volunteers

365 fingerprint records

11 dementia-friendly shops

Lin SY, et al. Aging Med Healthc 2023;14:162-168

Community Schools of Brain Health

Combined care **4,133** person-visit

Facebook followers **332**

Dementia Community Centers

Service: 861casea

Satisfaction:100%

稻香里辦

桃源里辦

關渡學苑
稻香

豐年里辦

一徳里辦

關渡學苑
忠義

關渡里辦

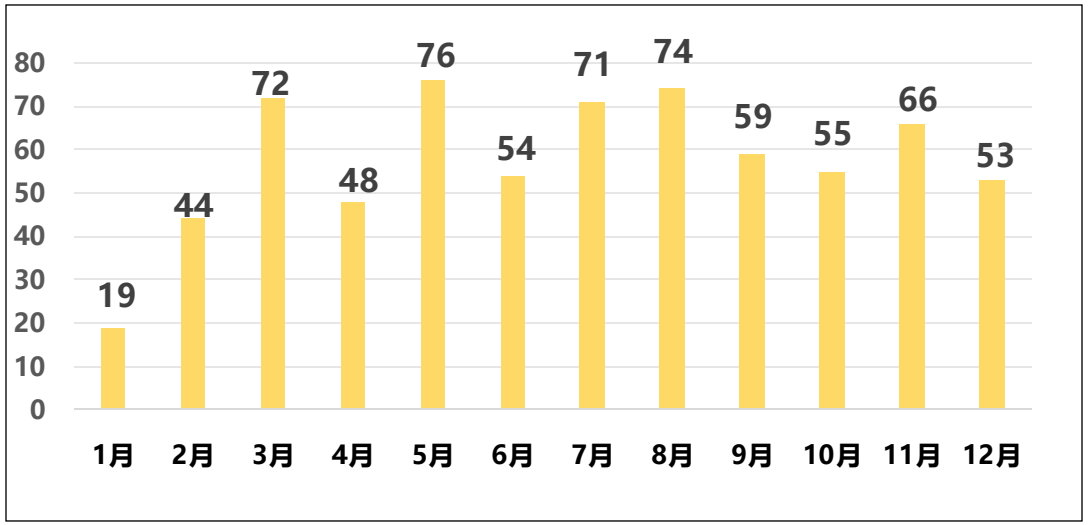
益智學堂

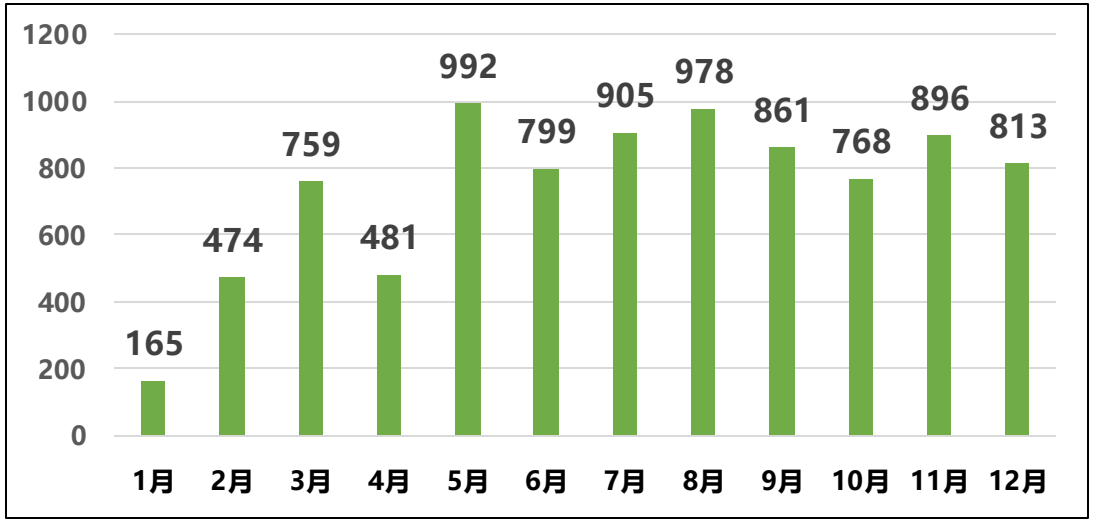
樂齡中心

八仙里辦

Gandaulogy Academy for TIGER Implementation

Gandaulogy Academy for TIGER





691 classes, **8,891** person-visits

1. TIGER Intervention

4,310 person-visits

2. Entertainment social activities

1,857 person-visits

3. Health management programs

2,724 person-visits

關渡學

&andaulogy

TI&ER PROGRAM

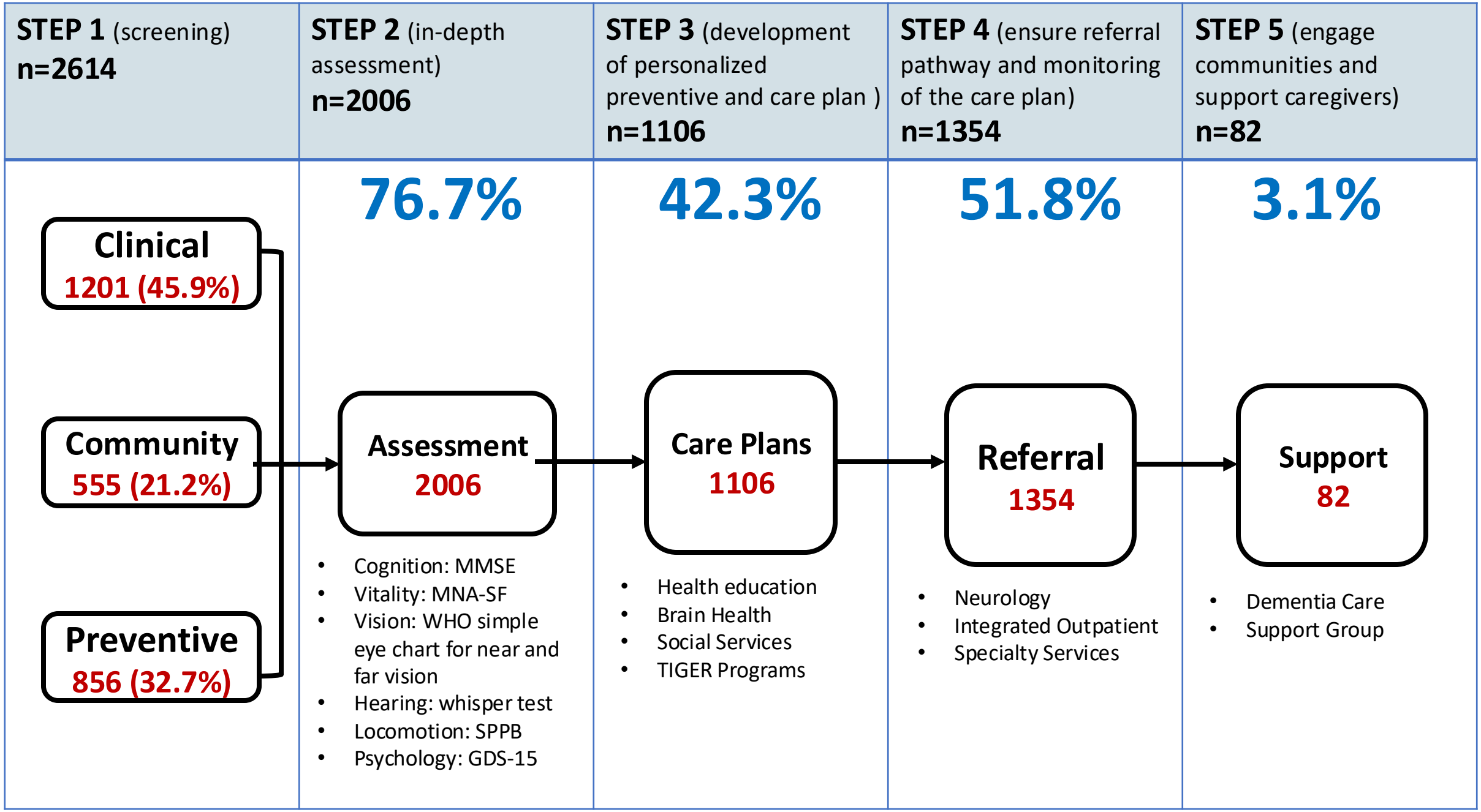
強化 Training

智慧 Intelligence

連結 Gathering

快樂 Enjoyment

回春 Rejuvenation


STEP 1 (screening)
n=2614
STEP 2 (in-depth assessment)
n=2006
STEP 3 (development of personalized preventive and care plan)
n=1106
STEP 4 (ensure referral pathway and monitoring of the care plan)
n=1354
STEP 5 (engage communities and support caregivers)
n=82
76.7%
42.3%
51.8%
3.1%
Clinical
1201 (45.9%)
Community
555 (21.2%)
Preventive
856 (32.7%)
Assessment
2006
Care Plans
1106
Referral
1354
Support
82
Cognition: MMSE
Vitality: MNA-SF
Vision: WHO simple eye chart for near and far vision
Hearing: whisper test
Locomotion: SPPB
Psychology: GDS-15
Health education
Brain Health
Social Services
TIGER Programs
Neurology
Integrated Outpatient
Specialty Services
Dementia Care
Support Group

Developing the Healthy Longevity Index

Lai HY, et al. JMIR Aging. 2025;8:e80034.

Wave 1

Wave 2

4-year HLI

86.72

HLI
+2.19

88.91

TIGER implementation for 3 years in Gan-Dau community increased the probability of healthy longevity (disability, dementia-free survival) for 3%

12-year HLI

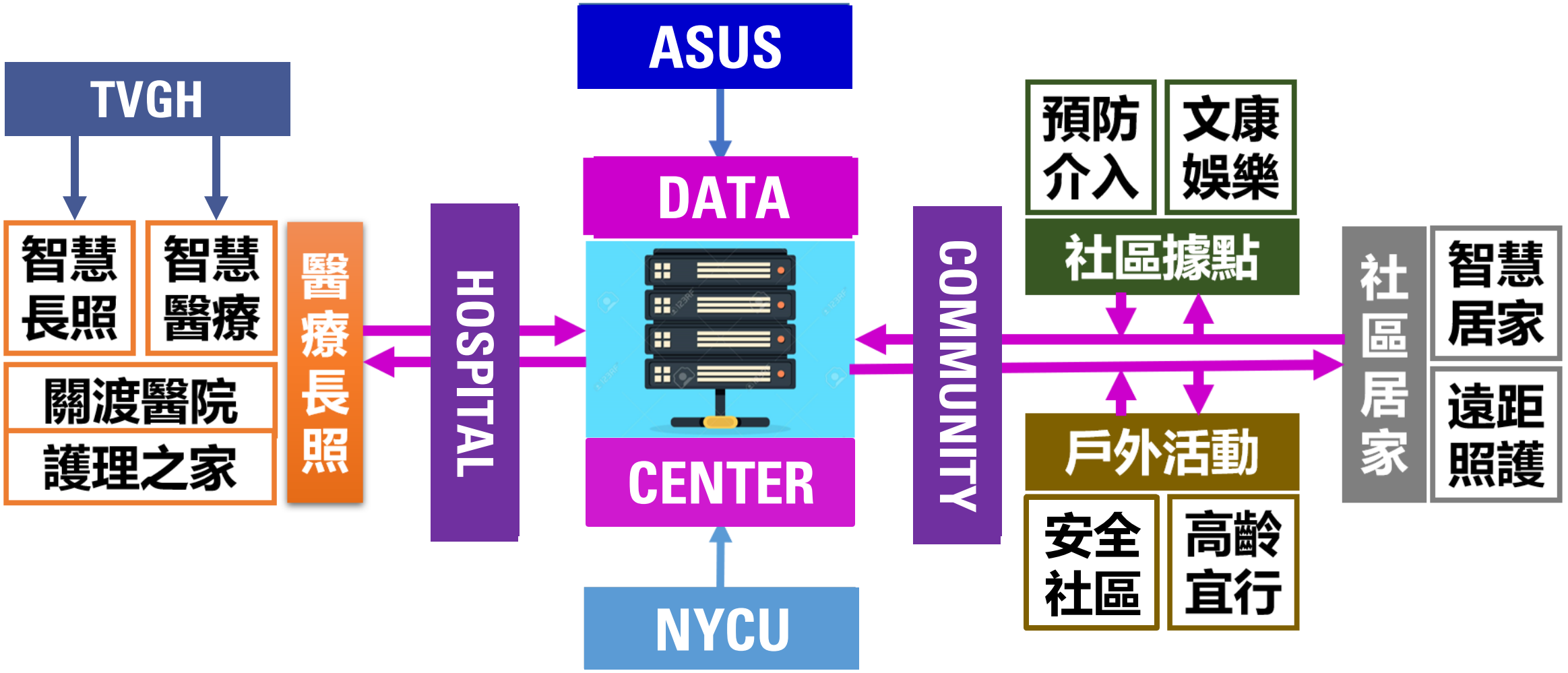
50.21

HLI
+3.52

53.73

Spillover Effects

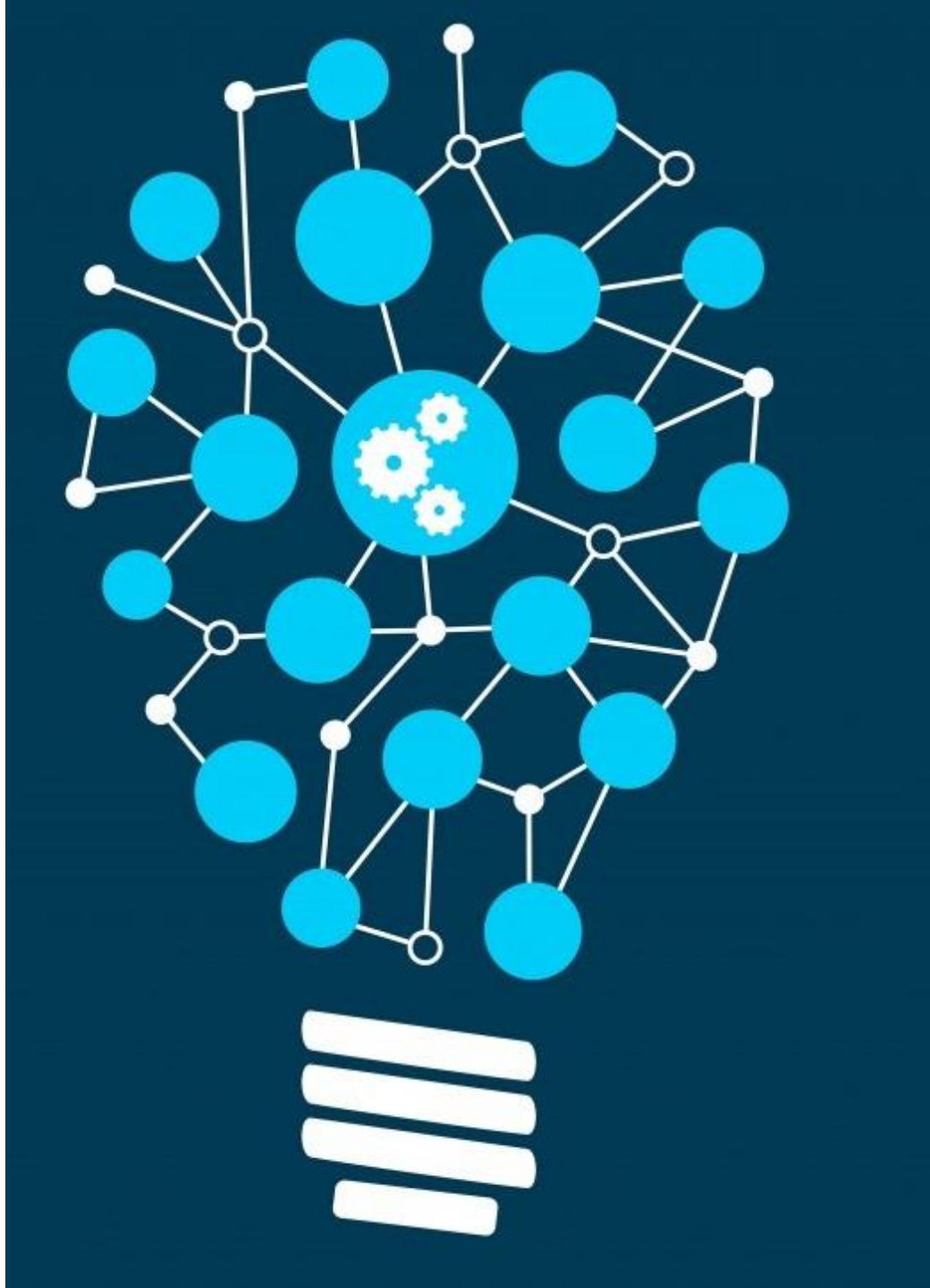
Cloud-Based Precision Healthy Aging



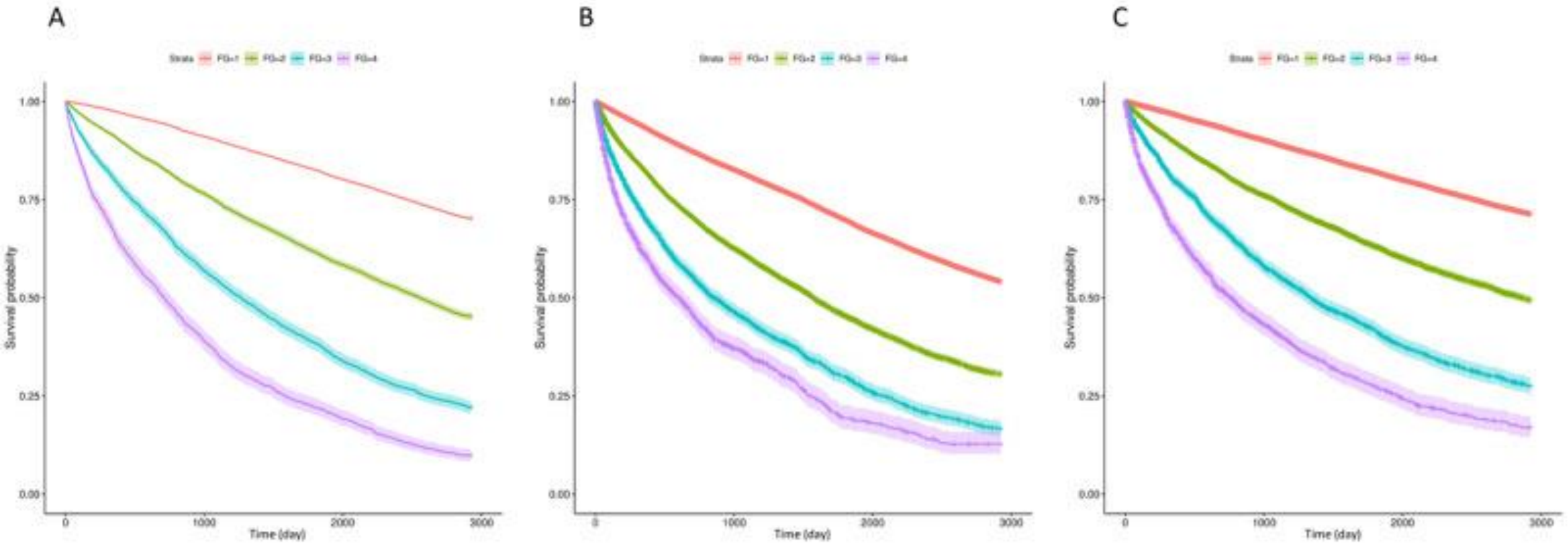
MAKING DATA-DRIVEN DECISIONS

HIS-based AI Algorithms

1. ML-based Frailty Stratification
2. ML-based Dementia Risk
3. ICD-10 Coding Assistant



Risk Stratification Using ML-mFI System

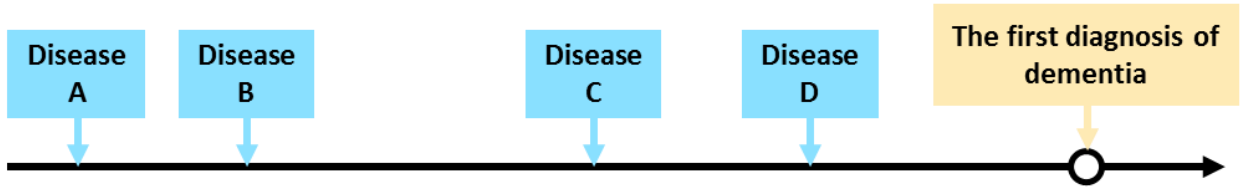


Peng LN, et al. J Med Internet Res 2022;22:e16213

Identifying at-risk people based on sequential outpatient visits

Step 1: identify all of the incident disease diagnosed before dementia in each dementia patient in training data

For example



Step 2: constructing possible triplet disease pathway according to the diagnosis date (each pathway has three disease)

For example

Disease A → Disease B → Disease C → Disease D

Possible triplet disease pathway

A → B → C	A → C → D
A → B → D	B → C → D

Step 3: summarizing all possible triplet disease pathway among all of dementia patients in training data

Possible triplet disease pathway in patient 1

A → B → C	A → C → D
A → B → D	B → C → D

Possible triplet disease pathway in patient 2

A → B → E	A → E → F
A → B → F	B → E → F

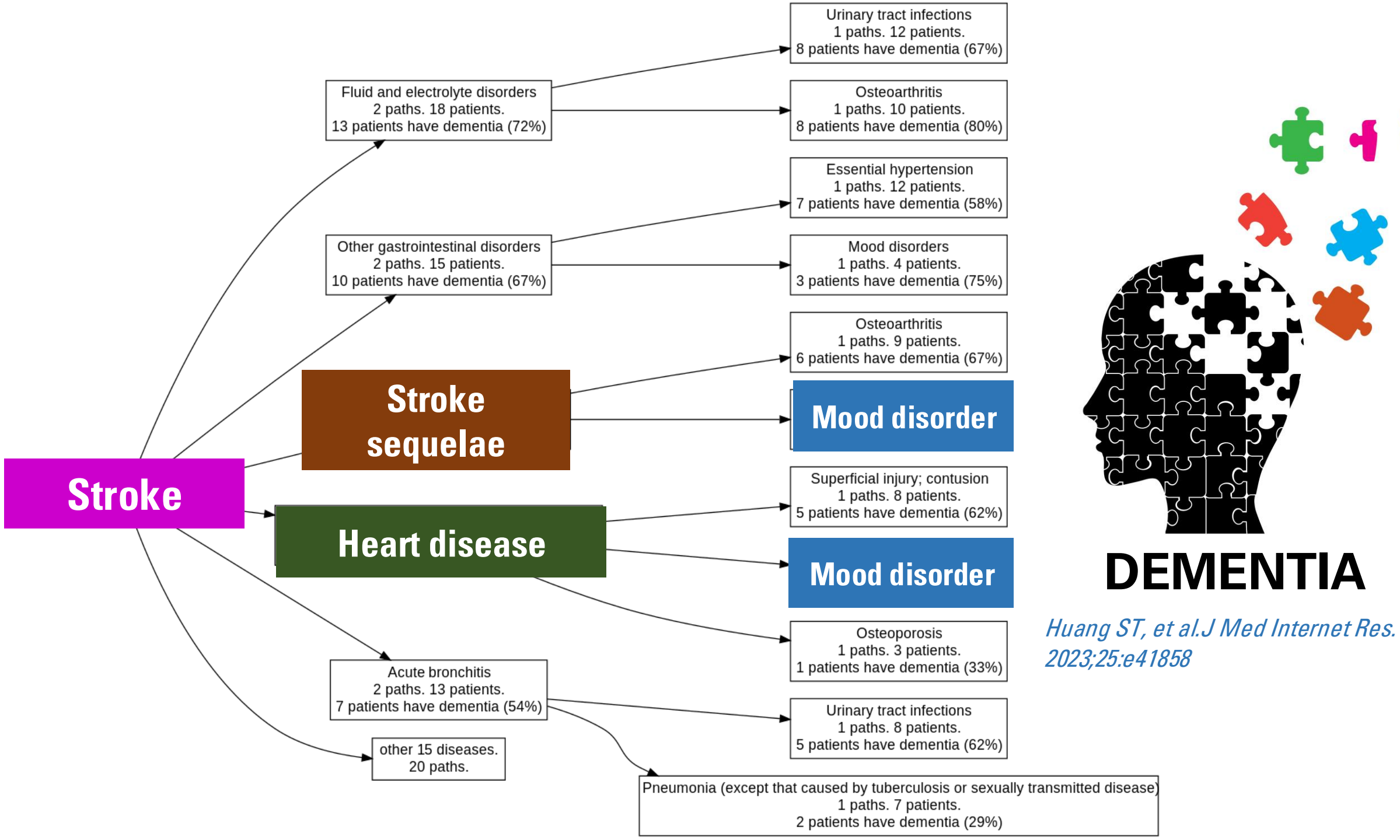
⋮

Possible triplet disease pathway in patient N

H → B → C	H → C → E
H → B → E	B → C → E

All possible triplet disease pathway among dementia patients in training data

A → B → C	A → C → D	H → B → C
A → B → D	B → C → D	H → B → E
A → B → E	A → E → F	H → C → E
A → B → F	B → E → F	B → C → E
⋮	⋮	⋮



DEMENTIA

Huang ST, et al.J Med Internet Res. 2023;25:e41858

ICD-10 Coding Assistant

Medical Record

Subjective:

Progressive abd. fullness and hiccup, acid regurgitation with N/V were also noted, no fever

Objective:

Drug Allergy: NIL;

Examination: 檢驗查範例(僅供參考)

Endo: GERD, LA Gr A ALT/AST=15/20, Total cholesterol=242, TG=221, HDL=50, LDL=158

Drug: 藥物範例(僅供參考)

Plan:

Code Recommendation

Code	Confidence	Name	Info	Delete
E78.5	98.74	高血脂症		
K21.0	96.17	胃食道逆流性疾病併食道炎		

V	Examination	Result	ICD-10	Abnormal
	藥物過敏	NIL		正常
	消化系統	GERD, LA Gr A	K21.9	異常
	肝功能	ALT/AST=15/20		正常
	膽固醇	242	E78.5	異常
	三酸甘油脂	221	E78.1	異常
	高密度膽固醇	50		正常
	低密度膽固醇	158	E78.5	異常

Smart Nursing Stations Control Workflow

Smart Humancentric Lighting System

Sleep quality improved 52%

時間	活動	色溫	Melanopic Ratio
08:00-09:00	個別活動	4000K	0.588
09:00-09:50	早安體操（坐姿）	4000K	0.588
09:50-10:50	分班課程 / 個別物理治療	5000K	1
11:00-11:30	健口瑜珈（坐姿）	5000K	1
11:30-12:30	午餐	5500K	1
12:30-13:30	午休	3000K	0.445
13:30-14:00	健康體操（坐姿）	4000K	0.588
14:00-15:00	分班課程 / 個別物理治療	4000K	0.588
15:00-15:30	休息與點心	4000K	0.588
15:30-16:30	個別活動	4000K	0.588
16:30-17:00	個別活動	3000K	0.445

Lan CH, et al. Arch Gerontol Geriatr. 2023;115:105112.

Motion-Sensing Smart Mattress


No more bedside falls and pressure injuies

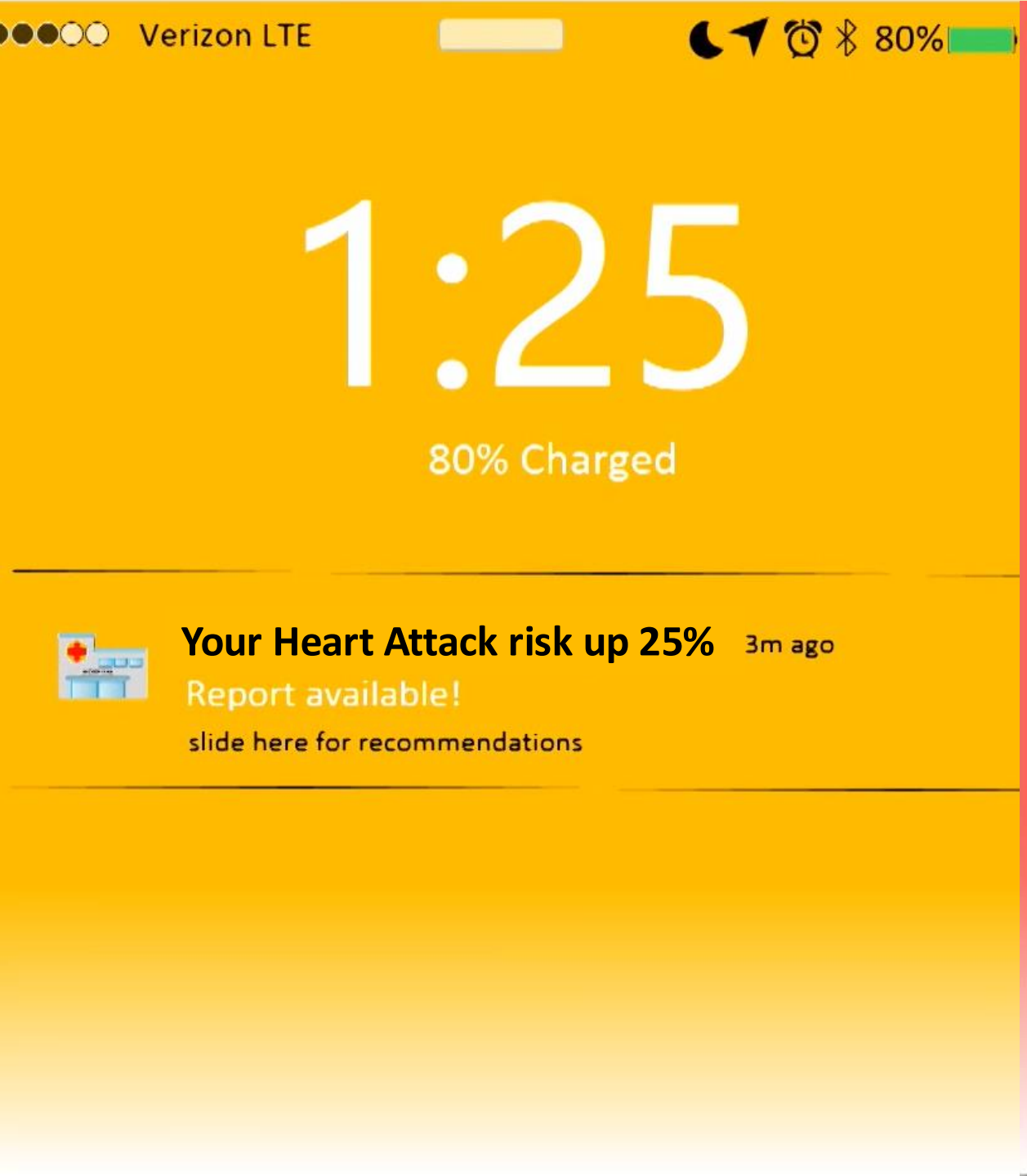
ASUS 國立陽明交通大學 NATIONAL YANG MING CHIAO TUNG UNIVERSITY 臺北市立關渡醫院 委託臺北榮民總醫院經營

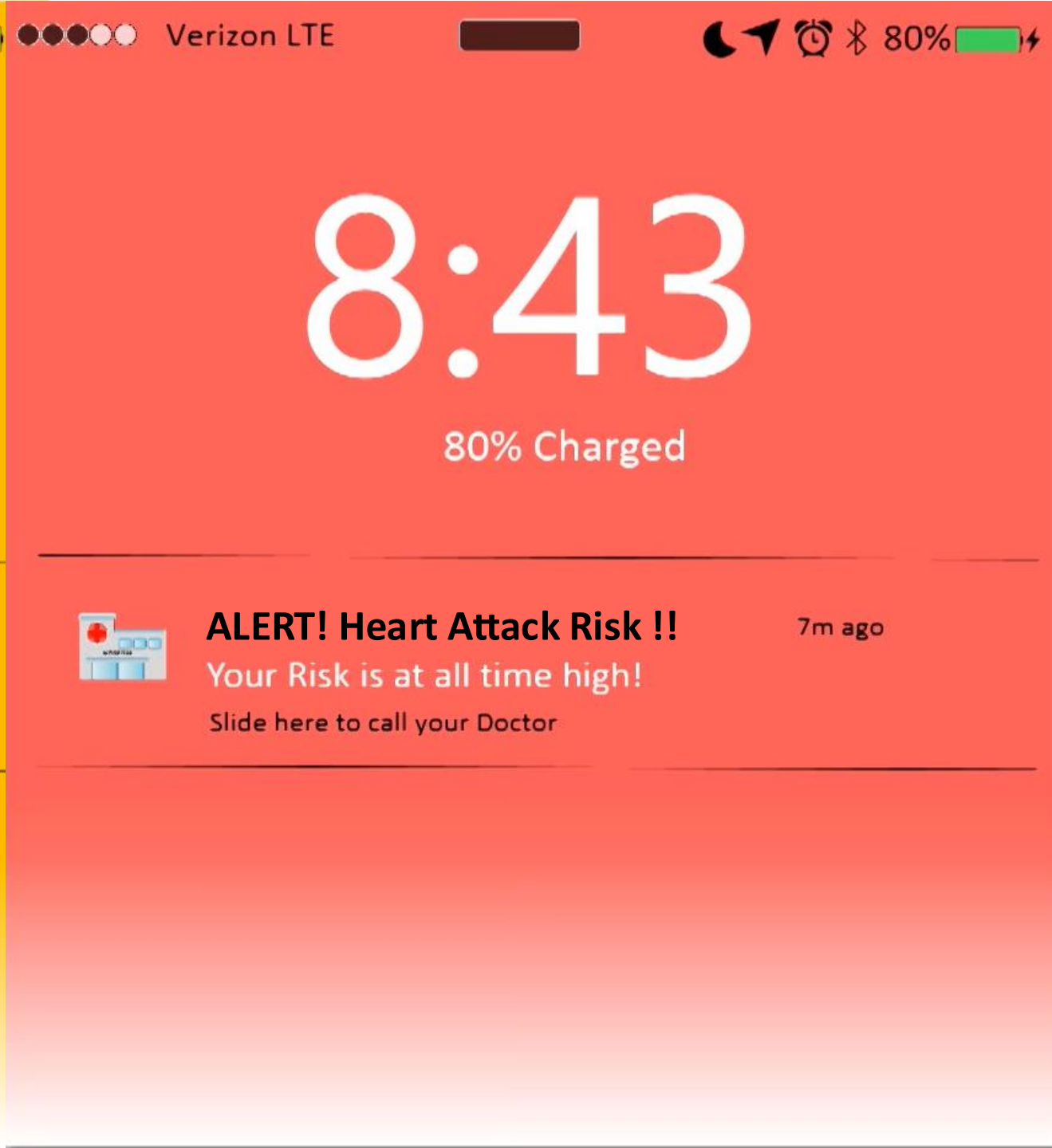
iHARP

Healthy Aging & Rejuvenation Platform

intelligent innovative individual

Healthy Aging & Rejuvenation Platform


Verizon LTE
80%
1:25
80% Charged
Your Heart Attack risk up 25%
3m ago
Report available!
slide here for recommendations


Verizon LTE
80%
8:43
80% Charged
ALERT! Heart Attack Risk !!
7m ago
Your Risk is at all time high!
Slide here to call your Doctor

Personal Healthcare

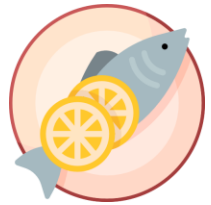
- Unleash your potential for a vibrant life with our empowering health app!-

1. Track health data with personalized assessments
2. AI recommendations for specified health concerns
3. Convenient access to daily shopping needs
4. Seamless integration with community healthcare system

Dietary Appropriateness Self Assessment

75 years old, male, medium physical activity

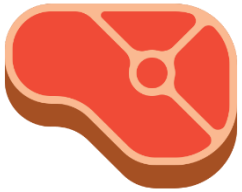
Score = (Actual intake ÷ Recommended intake) × 10; if the value exceeds the standard, the score is capped at 10.

	Vegetables:3 servings Fruits: 2 servings		Whole grains: 3 bowls	Nuts and soy products: 1 servings	Fish: about 3 taels (≈112 g) per week	
Recommended Intake (Personalized based on physical activity level, age, and gender)						
Reported intake (questionnaire data)	2	1	3	3	3	Subtotal 41.7
Dietary Score	6.7	5	10	10	10	
	(2÷3) x 10	(1÷2) x 10	(3÷3) x 10	3 >1	(3÷3) x 10	

Dietary Appropriateness Self Assessment

75 years old, male, medium physical activity

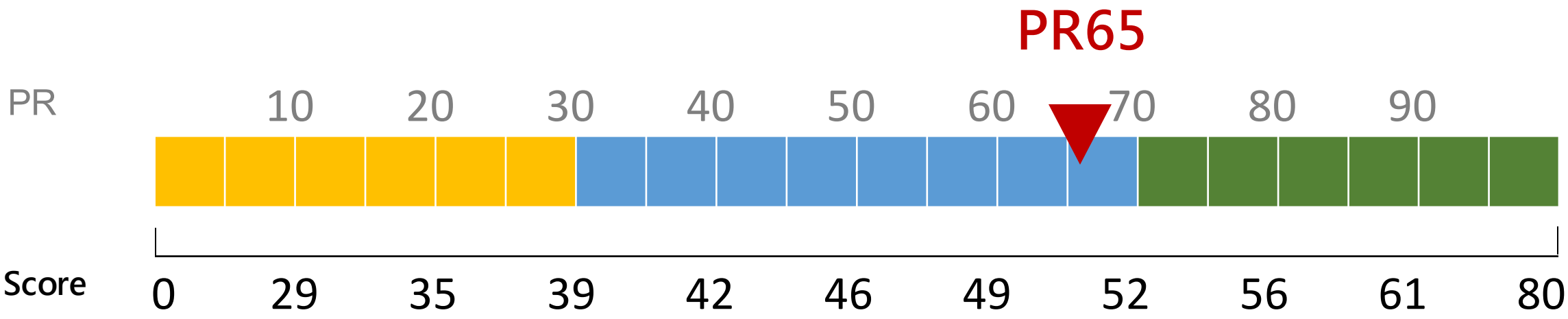
Score = (Actual intake ÷ Recommended intake) × 10; if the value exceeds the standard, the score is capped at 10.

	Red meat: less than 1.5 servings		Alcohol: less than 1 drink	Sugar-sweetened beverages / fruit juice: less than 8 oz	
Recommended Intake (Personalized based on physical activity level, age, and gender)					
Reported intake (questionnaire data)	0.5		1.2	550 ml	Subtotal =6.7
Dietary Score	6.7	5	0	0	
	10-(0.5÷1.5) x 10		1.2 >1	550*1 >8*28.35 g	

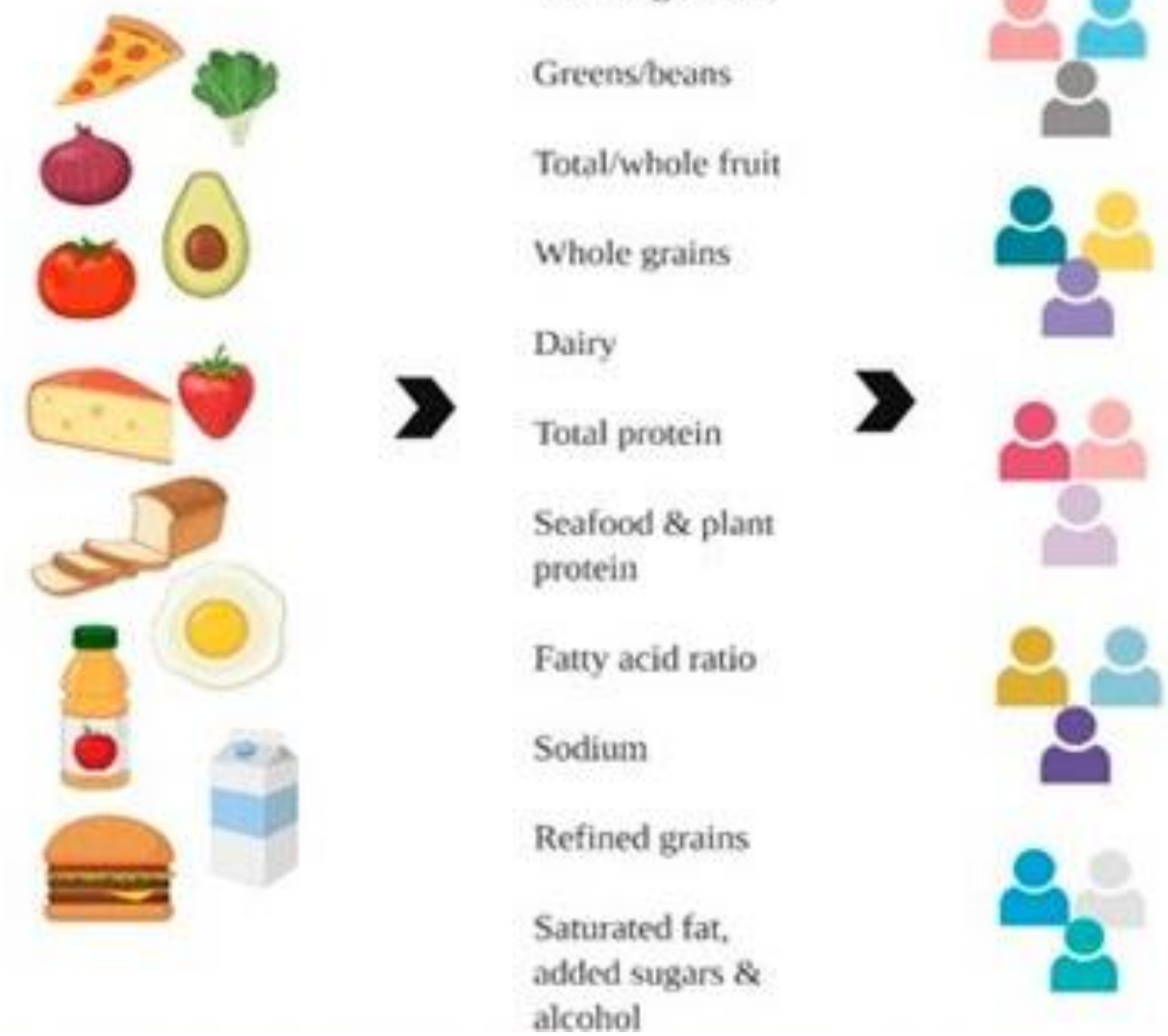
The closer the actual intake is to the recommended servings, the higher the score.

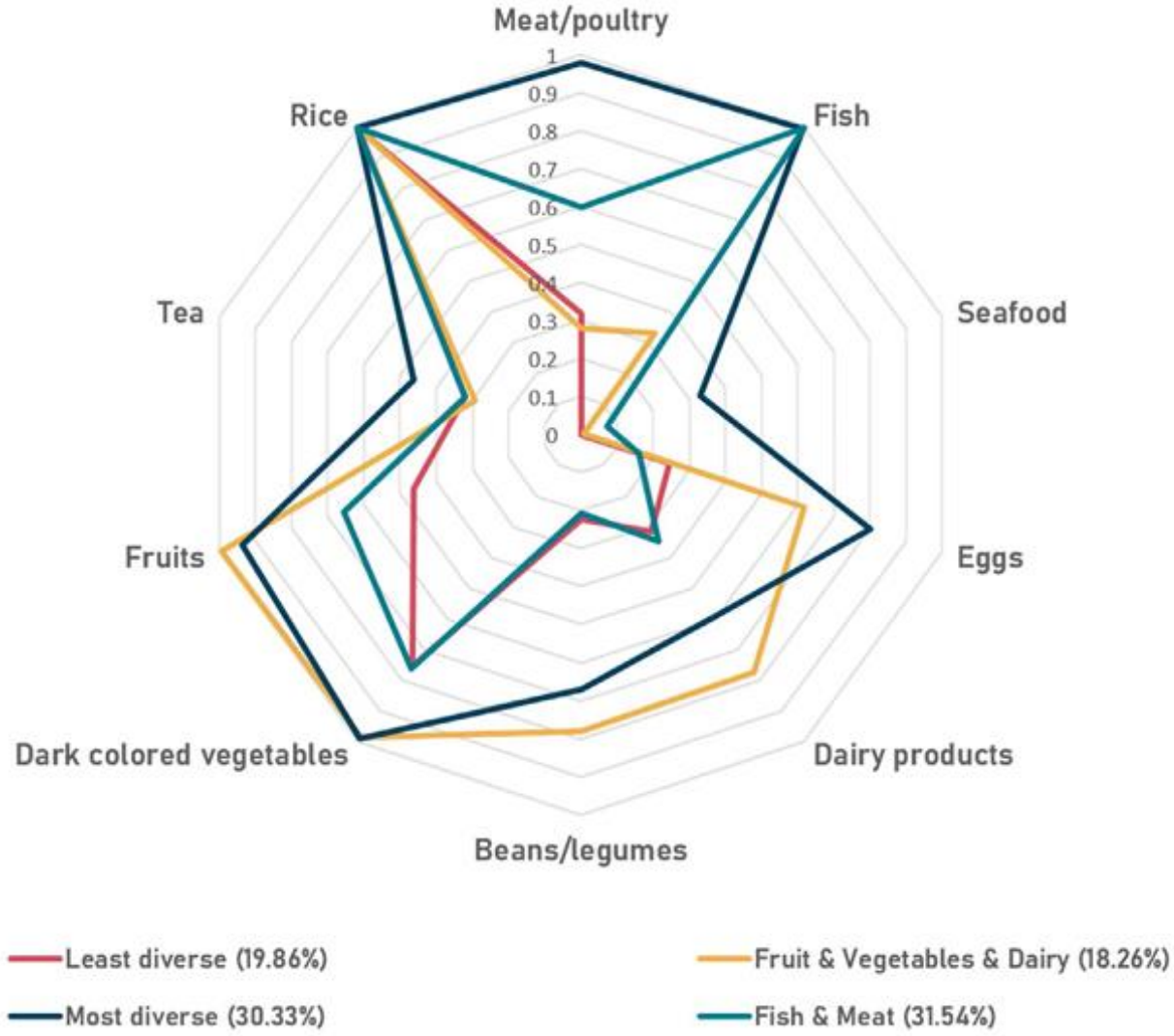
Dietary Habits in Percentile Rank

Modification of the all-cause Hospitalization scale to a PR Value format to mitigate public concern



Your Dietary Score Outperforms 65% of Participants in the National Nutrition and Health Survey





Guan ST, et al. J Nutr Health Aging. 2024;28(2):100025.

Mapping Your Health and Life

- Selecting favorite and delicious foods through precision health-

生活活動強度	低		稍低		適度	
性別	男	女	男	女	男	女
熱量 (大卡)	1700	1400	1950	1600	2250	1800
全穀雜糧類 (碗)	3	2	3	2.5	3.5	3
未精製 (碗)	1	1	1	1	1.5	1
其他 (碗)	2	1	2	1.5	2	2
豆魚蛋肉類 (份)	4	4	6	4	6	5
乳品類 (杯)	1.5	1.5	1.5	1.5	1.5	1.5
蔬菜類 (份)	3	3	3	3	4	3
水果類 (份)	2	2	3	2	3.5	2
油脂與堅果種子類 (份)	5	4	5	5	6	5
油脂類 (茶匙)	4	3	4	4	5	4
堅果種子類 (份)	1	1	1	1	1	1

Exercise (Physical Activity Assessment)

The score is calculated based on participants' self-reported weekly exercise frequency, duration, and intensity.

1 Do you usually engage in physical exercise?

0: I do not exercise regularly

1: Less than twice per week

2: 3–5 times per week

3: More than 6 times per week

2 On average, how long do you exercise each time?

0: I do not exercise regularly

1: Less than 15 minutes

2: 15–30 minutes

3: More than 30 minutes

3 Do you usually sweat after exercising?

0: I do not exercise regularly

1: I do not sweat

2: I sweat a little

3: I sweat a lot

4 Do you usually feel out of breath after exercising?

0: I do not exercise regularly

1: Not out of breath

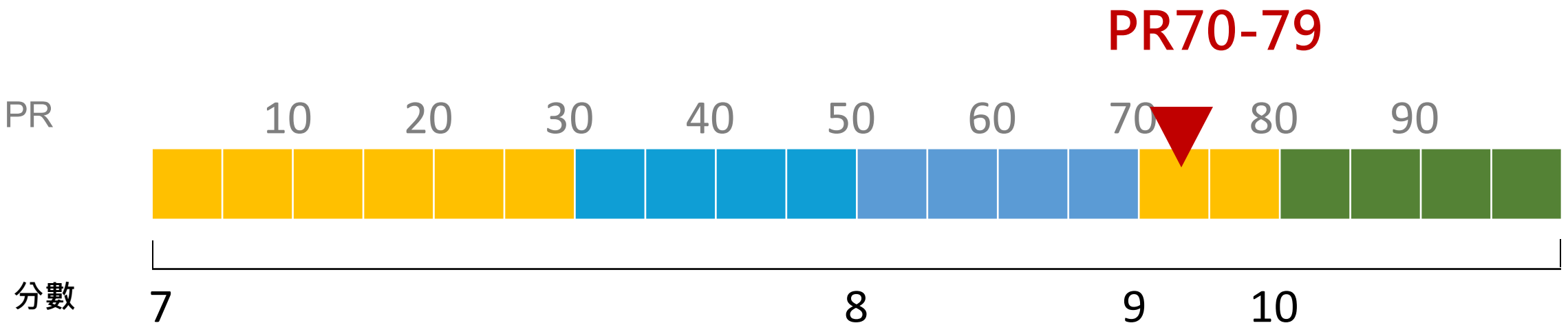
2: Slightly out of breath

3: Very out of breath

Score= exercise frequency+ duration + sweat+ breath

Exercise Patterns in Percentile Rank

Modification of the all-cause death to a PR Value format to increase public acceptance



Your Exercise Score Outperforms 70% of Participants in the Taiwan Longitudinal Study on Aging

A higher score corresponds to a higher PR value, indicating a lower overall health risk

Taipei City Health Artificial Intelligence Interactive Platform

log in

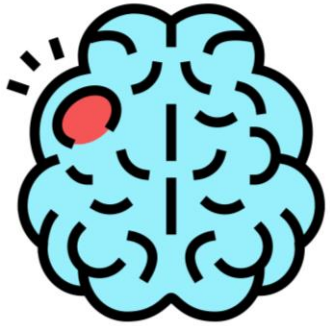
Healthy Longevity

Dietary Appropriateness

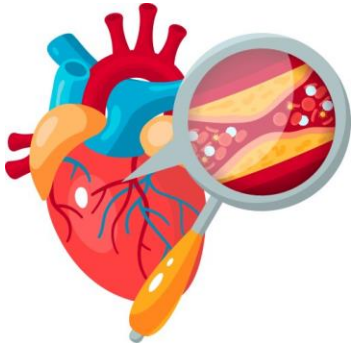
Physical Activity

Hypertension

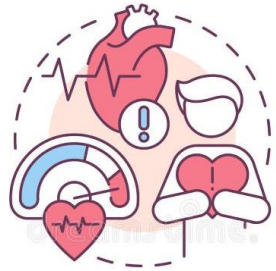
Diabetes



Stroke



CHD



MACE

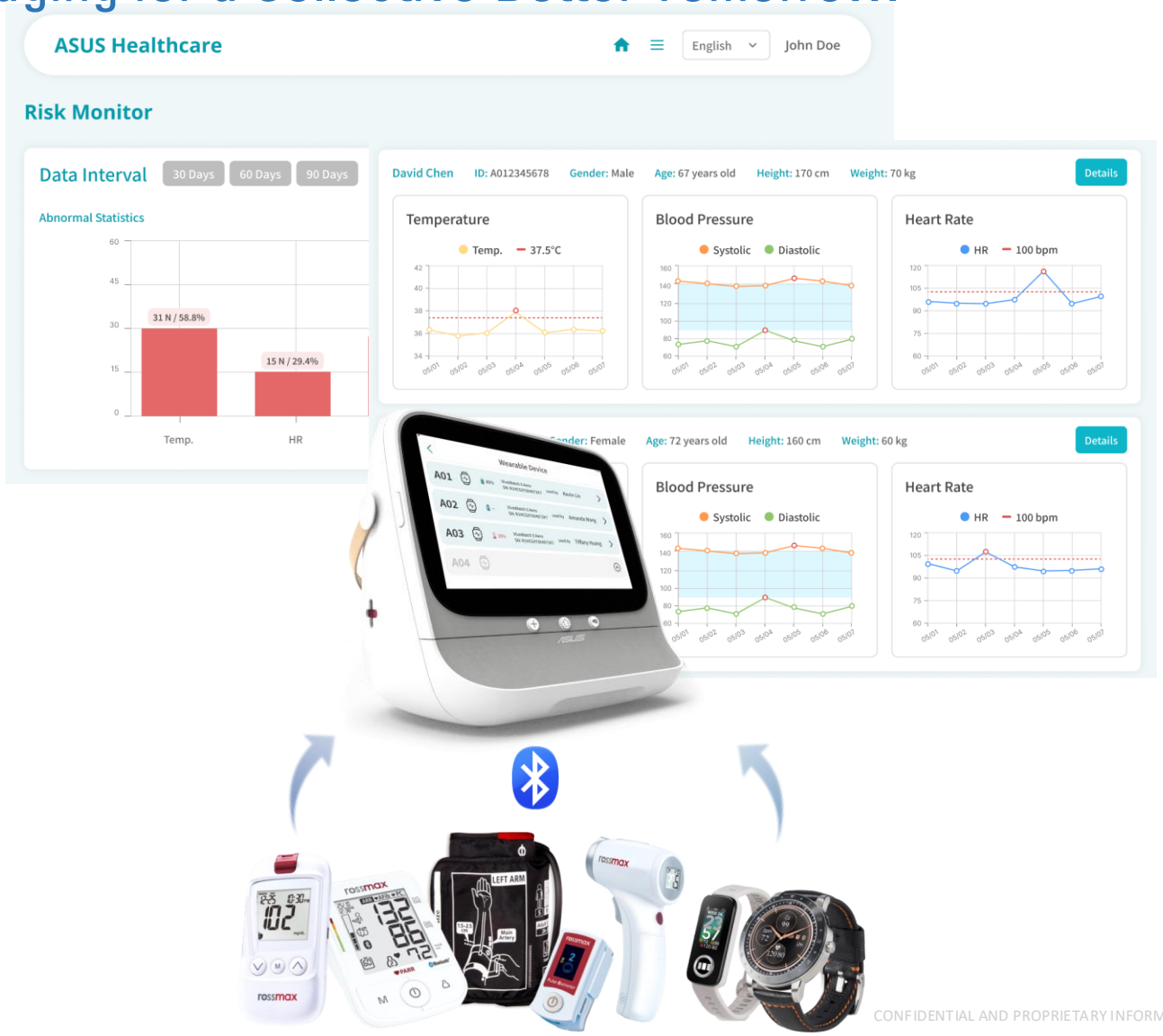
Home & Community Healthcare

Tracking, Detecting, and Managing for a Collective Better Tomorrow.

1. Rapid synchronization of measurement instrument data.

2. In addition to vital signs, activity records captured by the wristband also included

3. The data backend enables quick filtering of elderly with anomalies.



Interactive Social Robot – Zenbo Jr

- Connecting Personal Life to Healthy Longevity-

Continuous Health Management

Vital Sign Measurements

Health Questionnaires

Health Education


Zenbo Junior

2024 Presidential Hackthon

退輔會 高雄市政府 臺北榮總 臺中榮總 高雄榮總 關渡醫院

陽交大 九日生 高雄榮家

HEALTH + SOCIAL

MEDs

A&E

LIFE

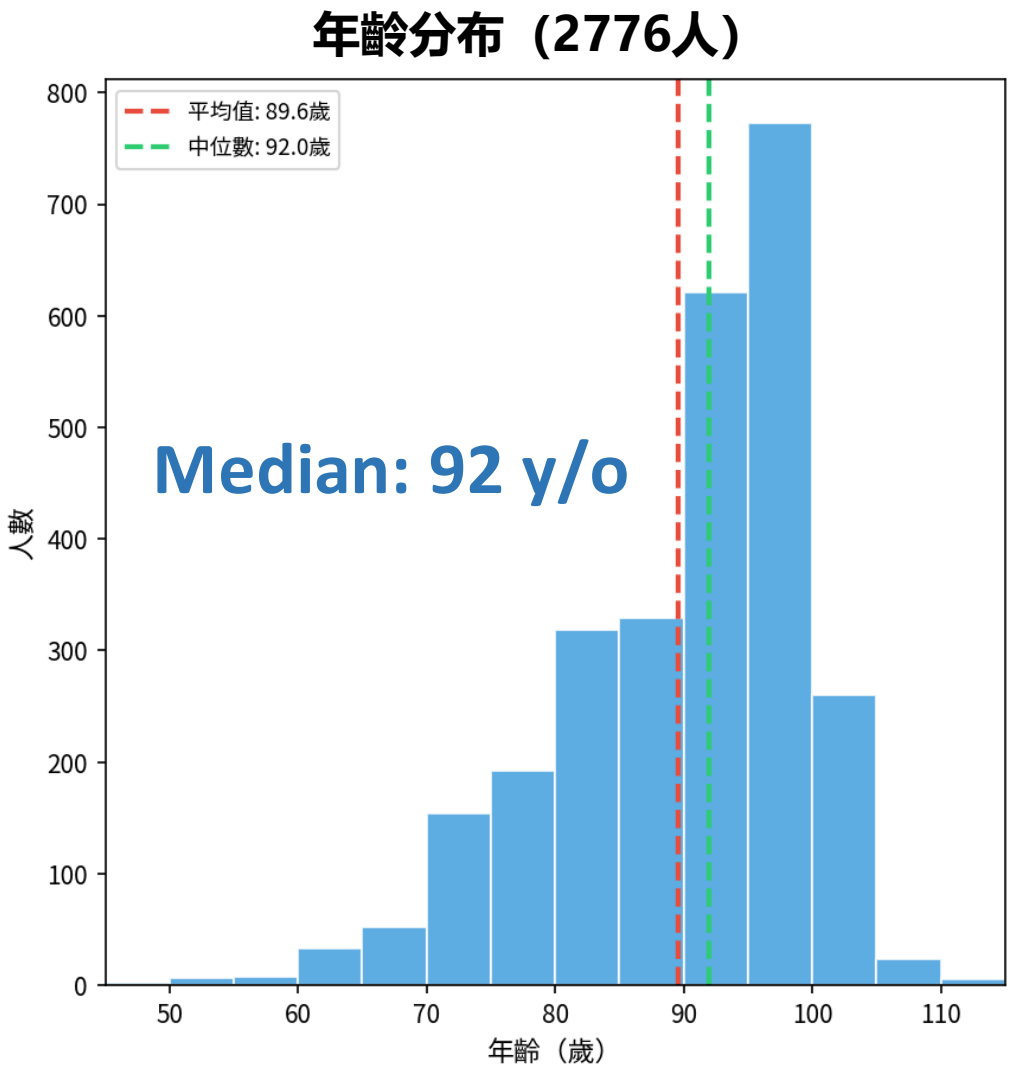
MIND

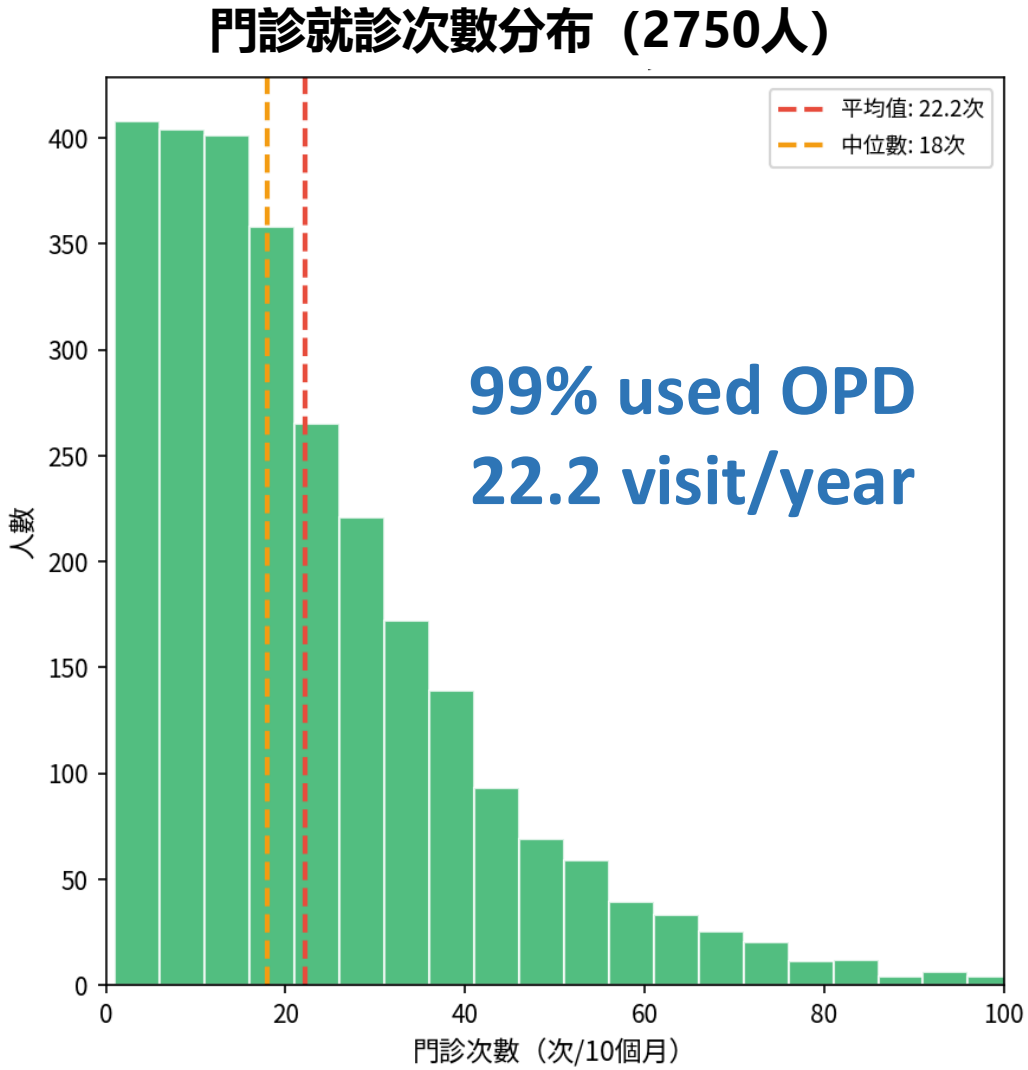
Solitary Living

Day Care

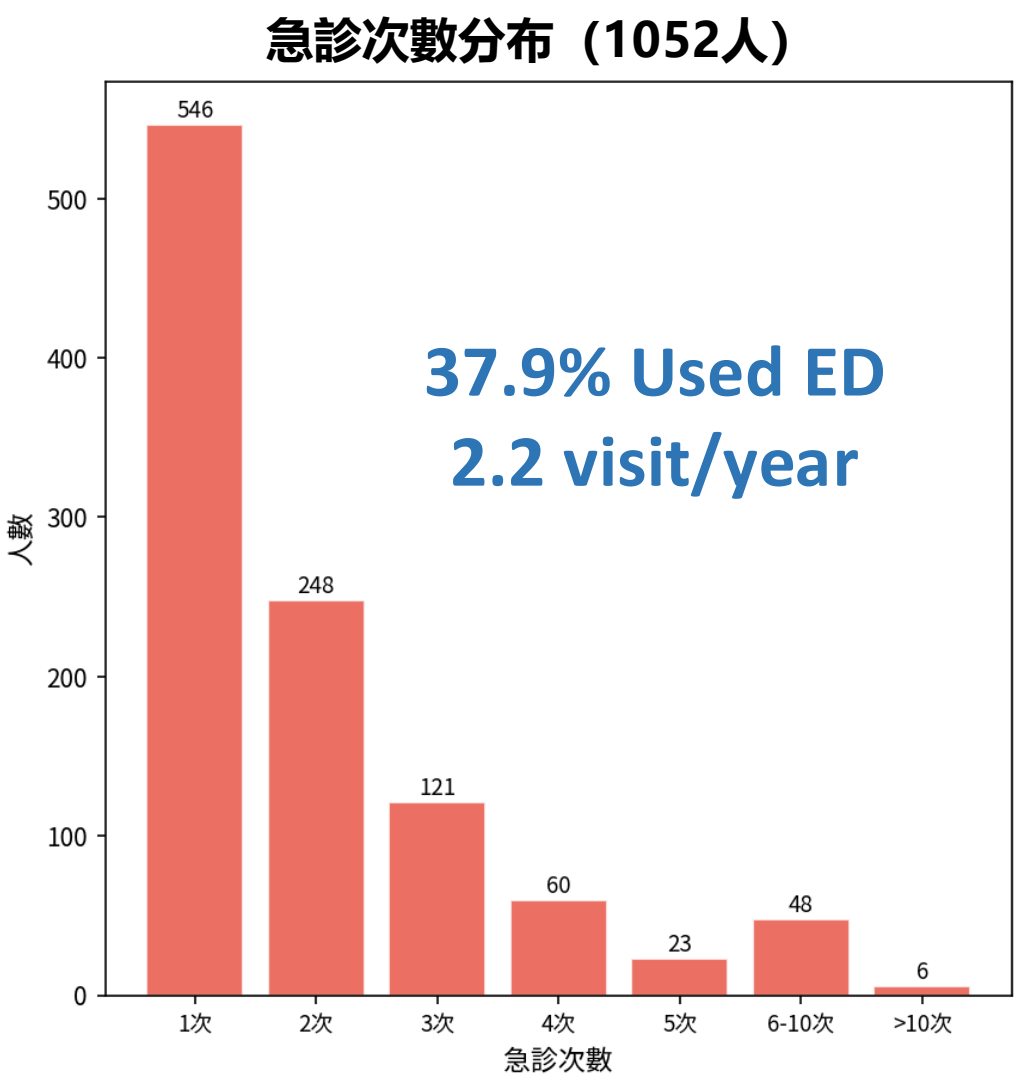
LTC

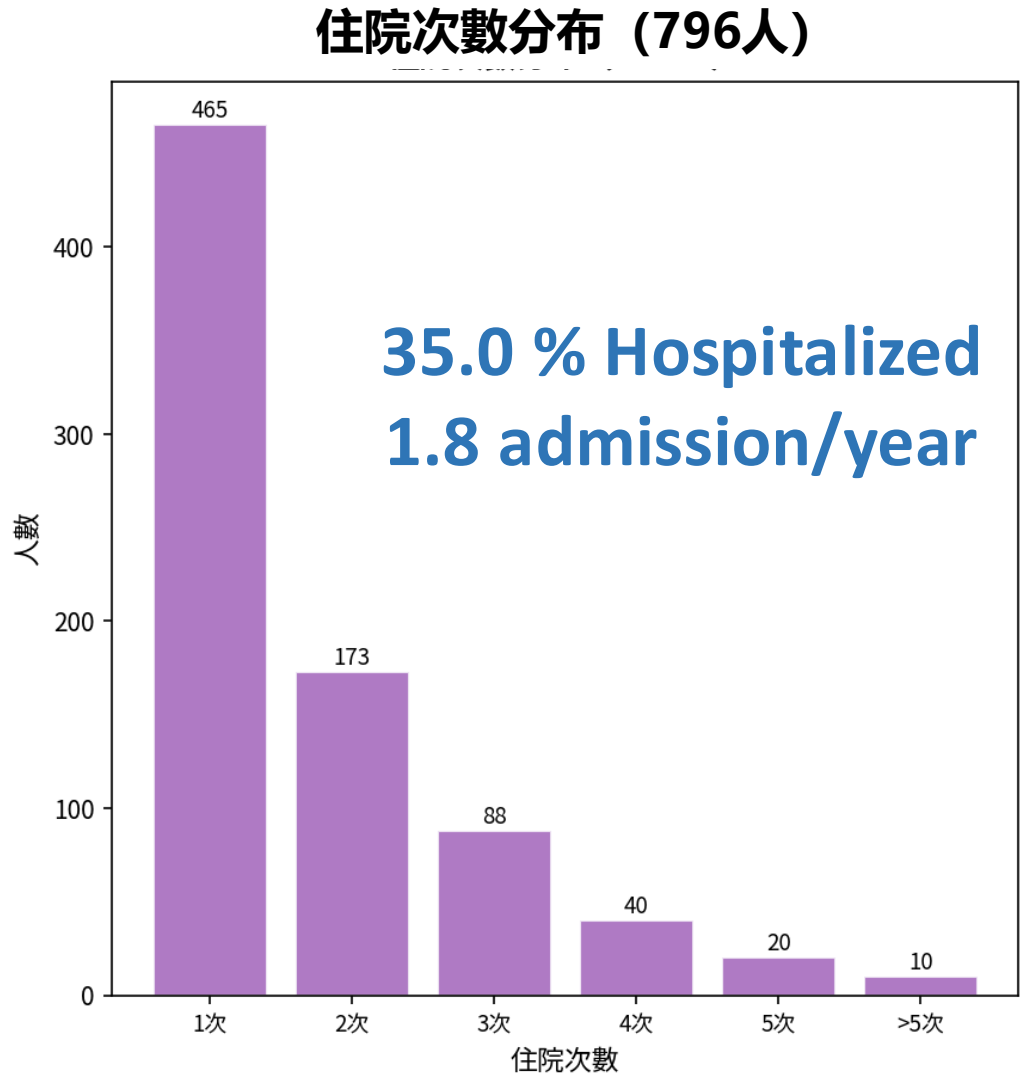
Community-Living At-Risk Seniors



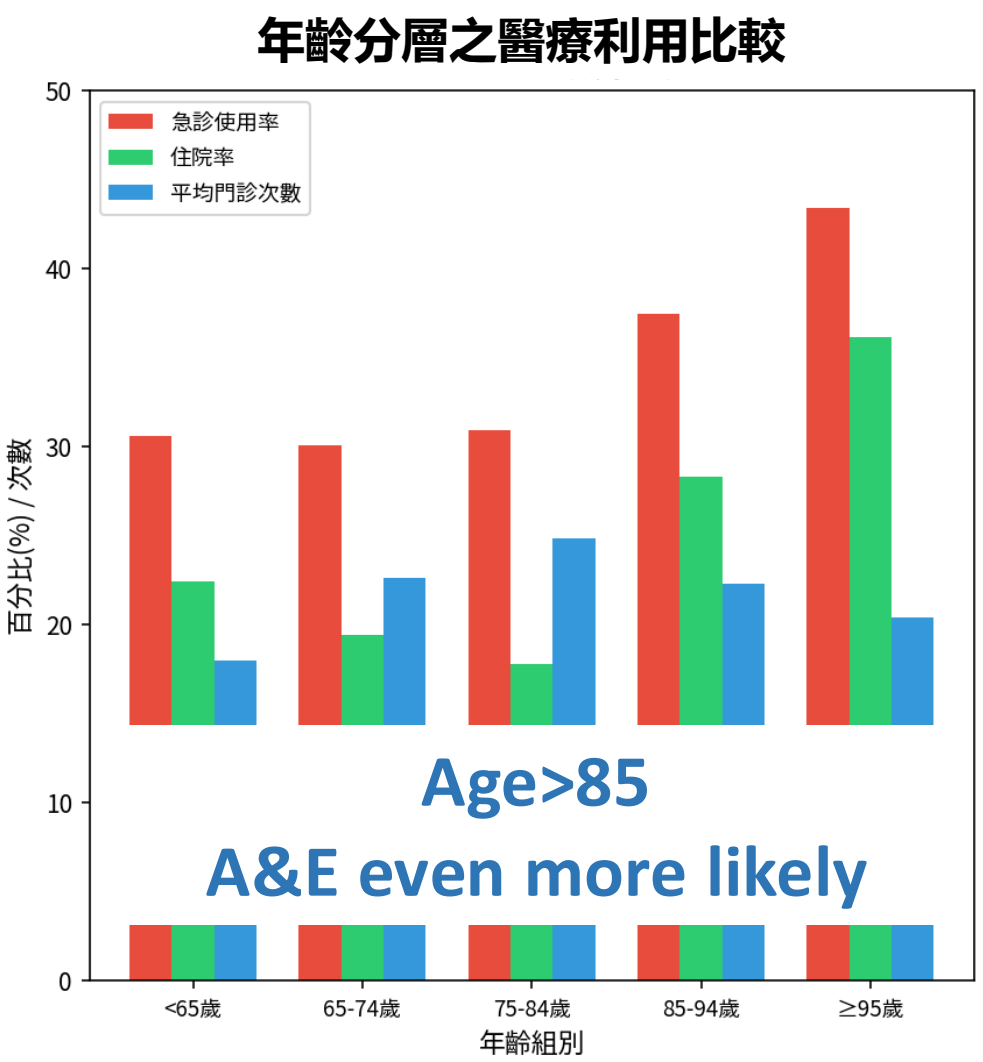


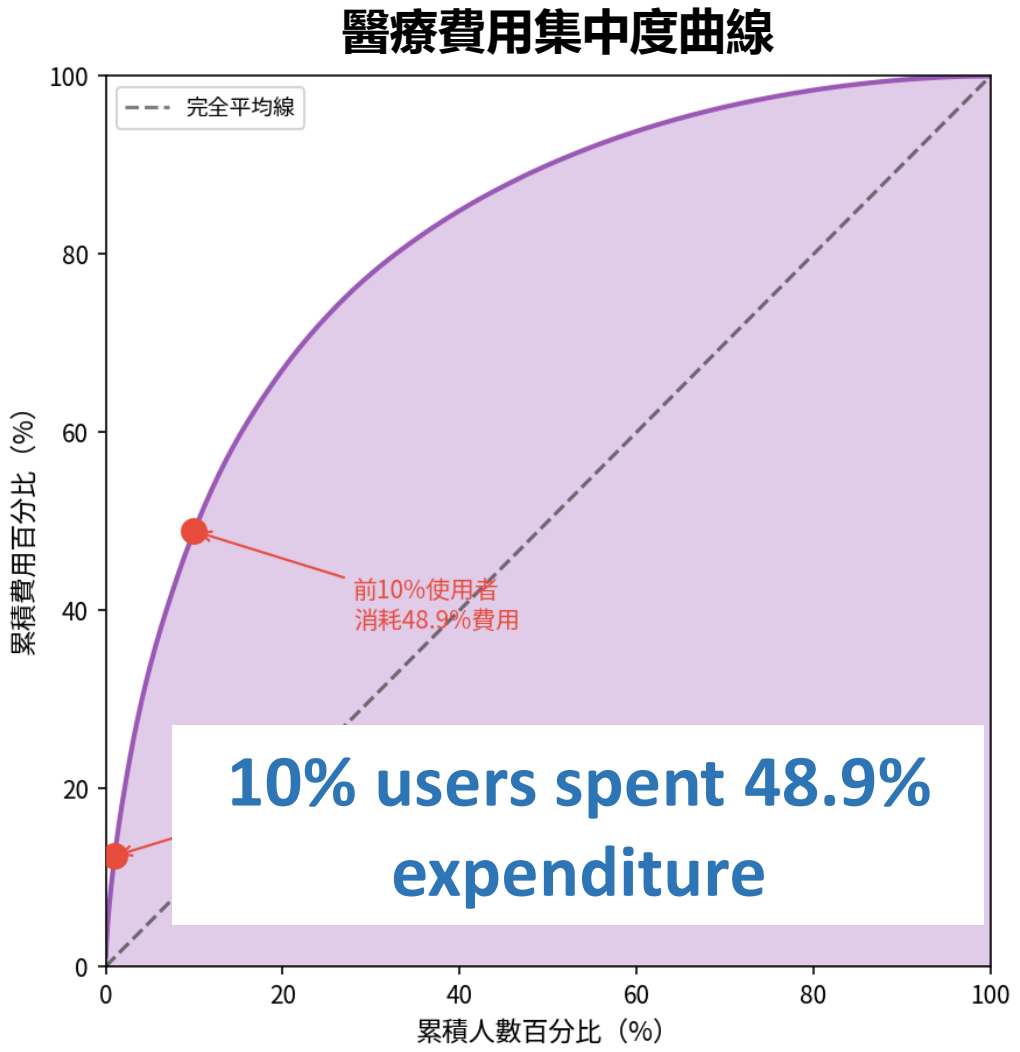
A&E Utilization of At-Risk Seniors





Overall Healthcare Utilization





Digital Transformation for Senior Care

Case Manage

IoT Monitors

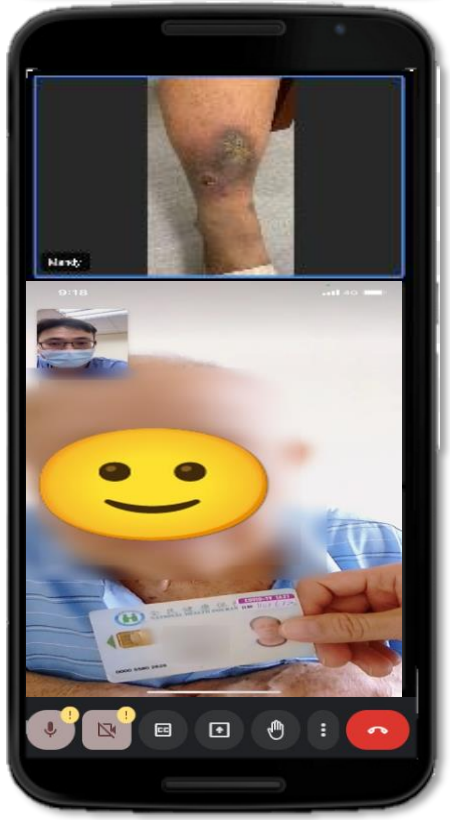

藍芽體溫計


藍芽血氧計


藍芽血壓計


施打抗生素

Telehealth



Care Transition

Efficacy & Expenditure

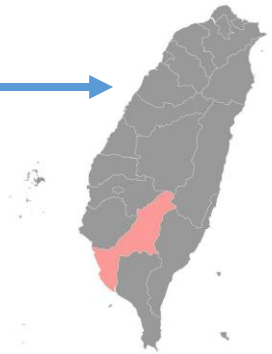
National Implementation

Data-Driven Senior Care

Year 1 (2025)

Year 2 (2026)

Year 3 (2027)



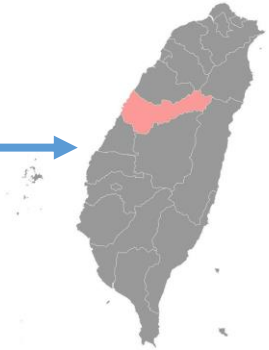
Kaohsiung

191

Apr-Oct

Implementation

Analysis



Taichung

211

Apr-Oct

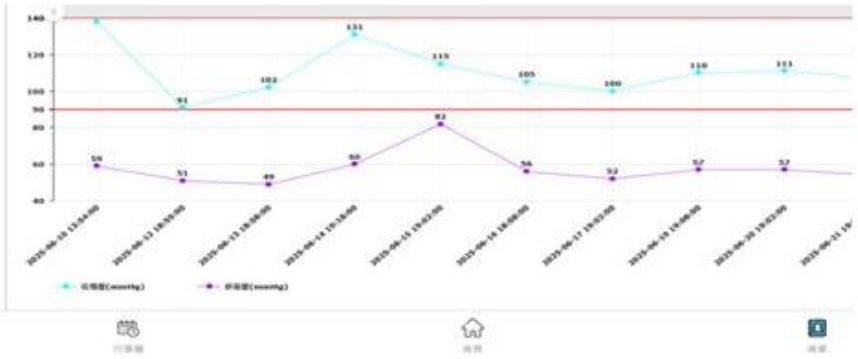
Traditional Model

Analysis

Strategy Modification

Real-World Care Senario

Blood Pressure



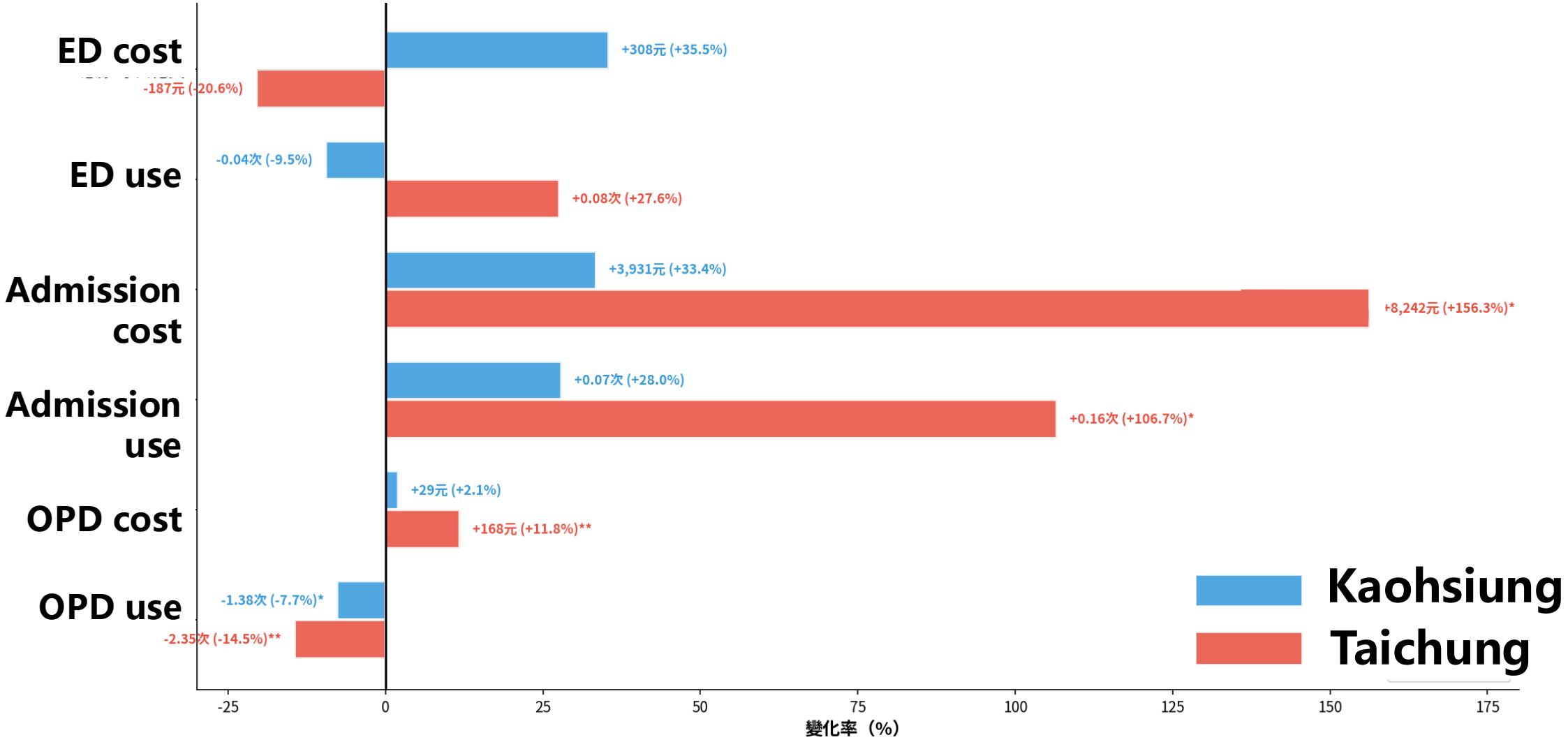
Repeated Measurements

6/19 高榮個管師：
伯伯年紀較大，這幾天血壓較低，有在服用血壓藥嗎？

6/19 榮服處社區組長:
伯伯表示只服用胃藥,鐵劑與防血栓用藥，血壓都高高低低，去年岡山醫院有開止暈藥

6/19 高榮個管師：
詢問王醫師，研判係因年齡導致姿態性低血壓，由藥物使用內容評估，應同時有貧血狀況，建議伯伯回診時將血壓數值及貧血與醫師討論，日常生活動作放慢，請社區組長多加探視

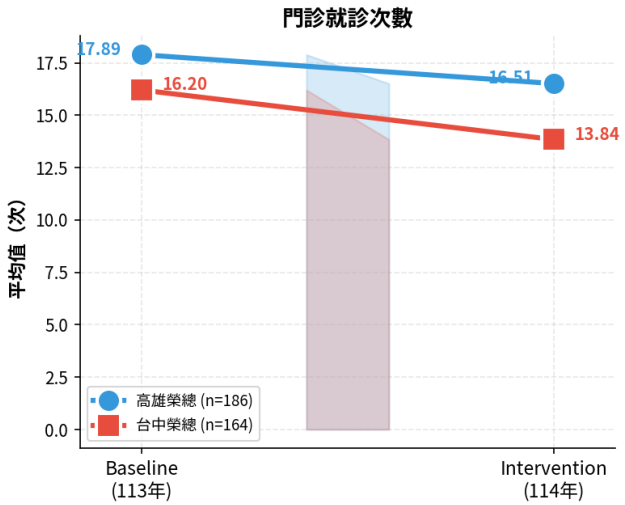
Digital Model Reduced A&E Events

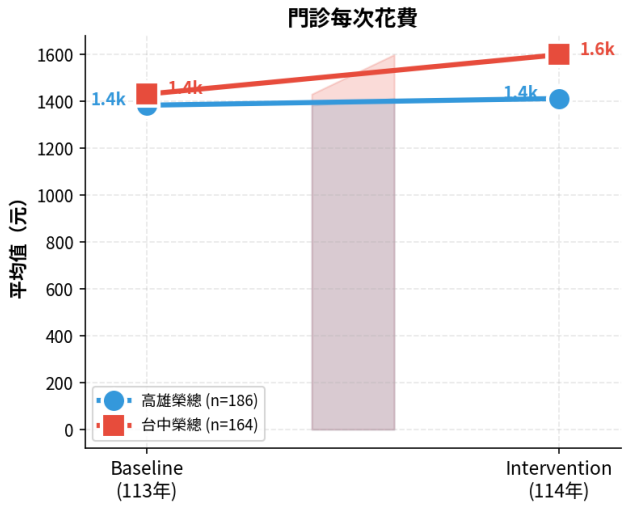


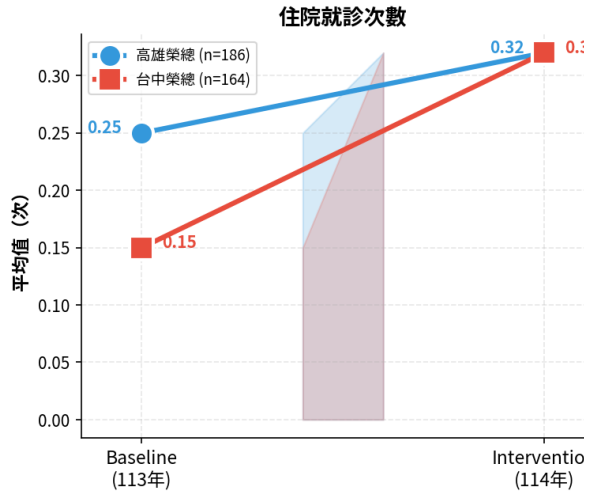
Digital Model Reduced Expenditure

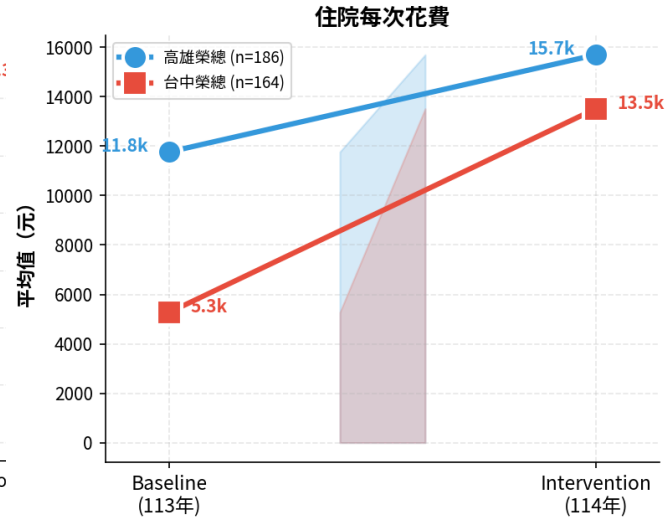
Regio	2024 Cost	2025 Cost	Differences	Change Rate
Kaohsiung	28,053 NTD	28,788 NTD	+735	+2.6%
Taichung	24,244 NTD	26,734 NTD	+2,490	+10.3%

Annual NHI growth rate: 4.7%



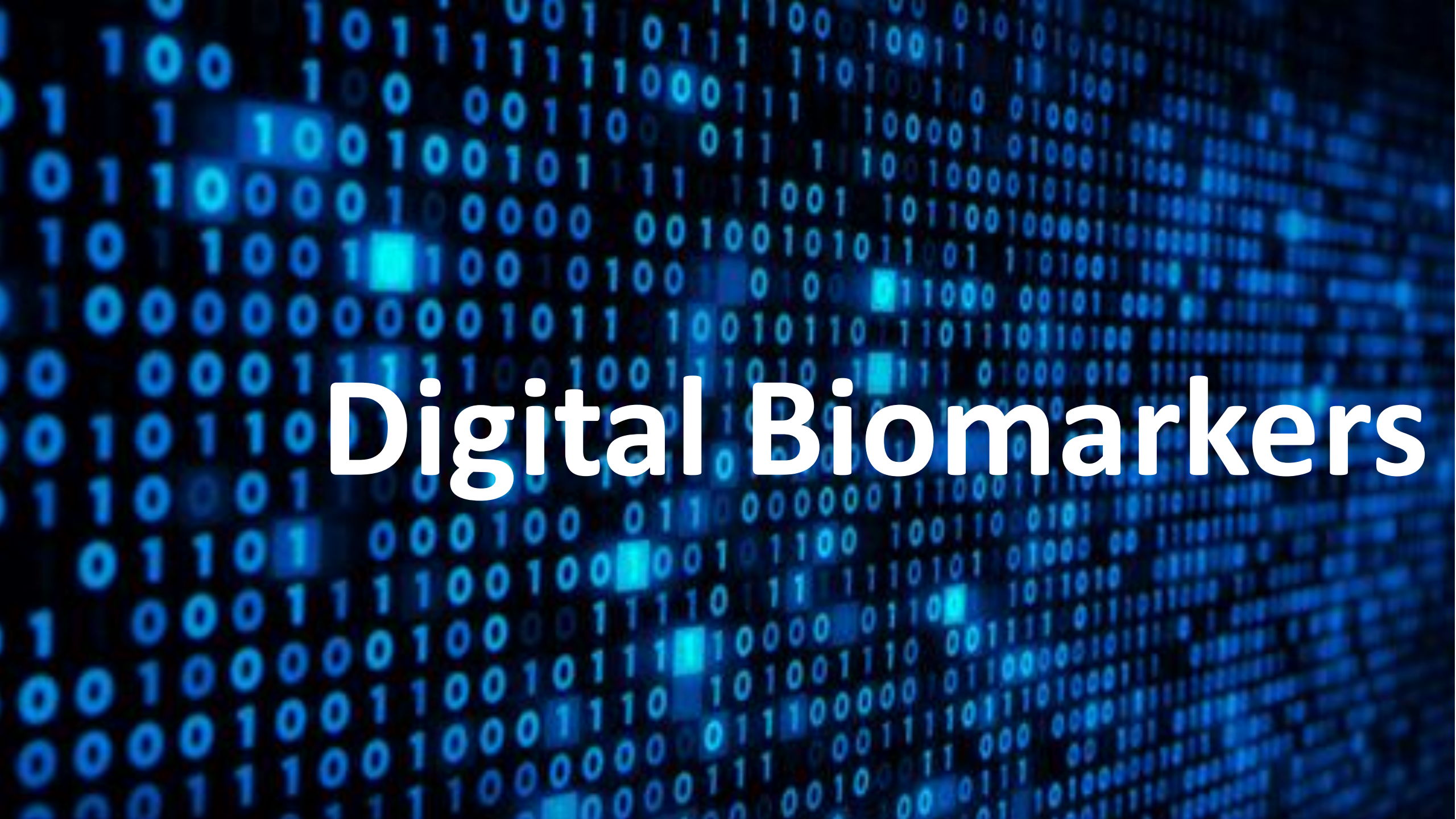






Kaohsiung Taichung

Controlled outpatient cost and reduced A&E


Digital Biomarkers

www.aging-us.com AGING 2021, Vol. 13, No. 15

Research Paper

Active wearable device utilization improved physical performance and IGF-1 among community-dwelling middle-aged and older adults: a 12-month prospective cohort study

Wei-Ju Lee[1,2], Li-Ning Peng[1,3], Ming-Hsien Lin[1,3], Ching-Hui Loh[1,4], Liang-Kung Chen[1,3,5]

[1]Aging and Health Research Center, National Yang Ming Chiao Tung University, Taipei, Taiwan
[2]Department of Family Medicine, Taipei Veterans General Hospital Yuanshan Branch, Yilan County, Taiwan
[3]Center for Geriatrics and Gerontology, Taipei Veterans General Hospital, Taipei, Taiwan
[4]Center of Health and Aging, Hualien Tzu Chi Hospital Buddhist Tzu Chi Medical Foundation, Hualien County, Taiwan
[5]Superintendent Office, Taipei Municipal Gan-Dau Hospital, Taipei, Taiwan

Correspondence to: Liang-Kung Chen; **email:** lkchen2@vghtpe.gov.tw
Keywords: walking speed, wearable device, average steps, community-dwelling older adults
Received: May 18, 2021 **Accepted:** July 17, 2021 **Published:** August 3, 2021

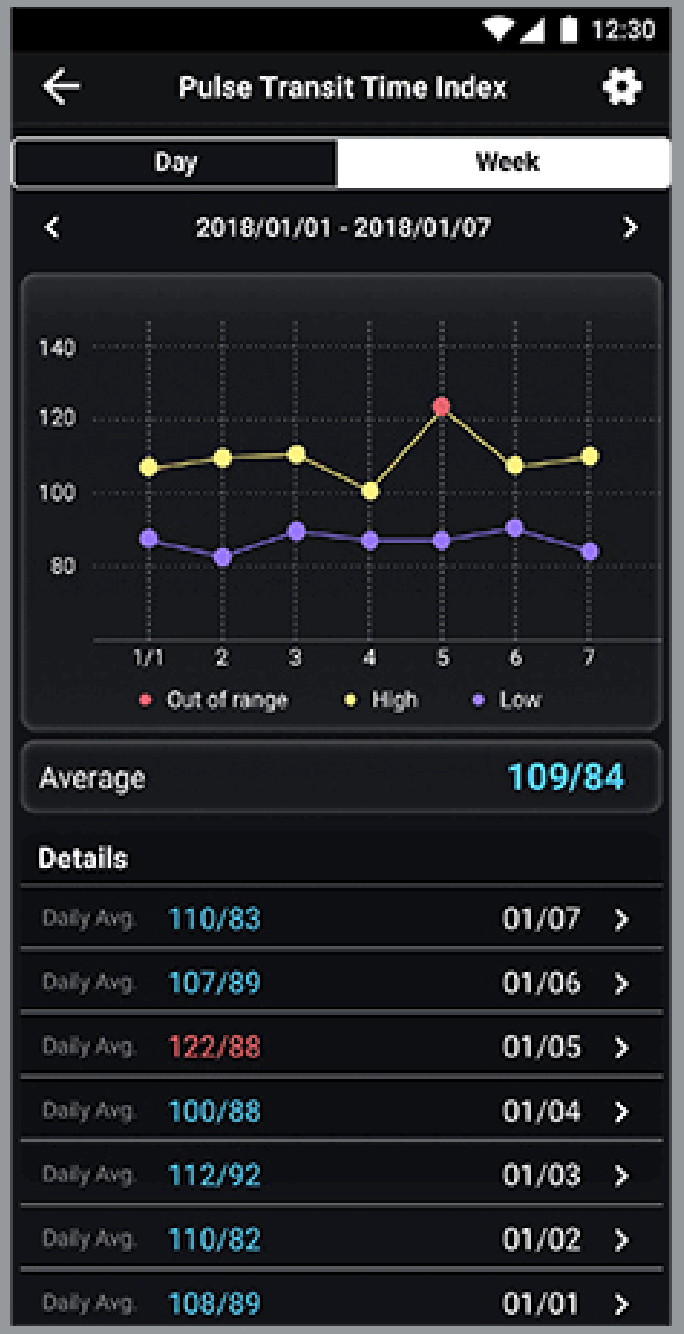
ABSTRACT

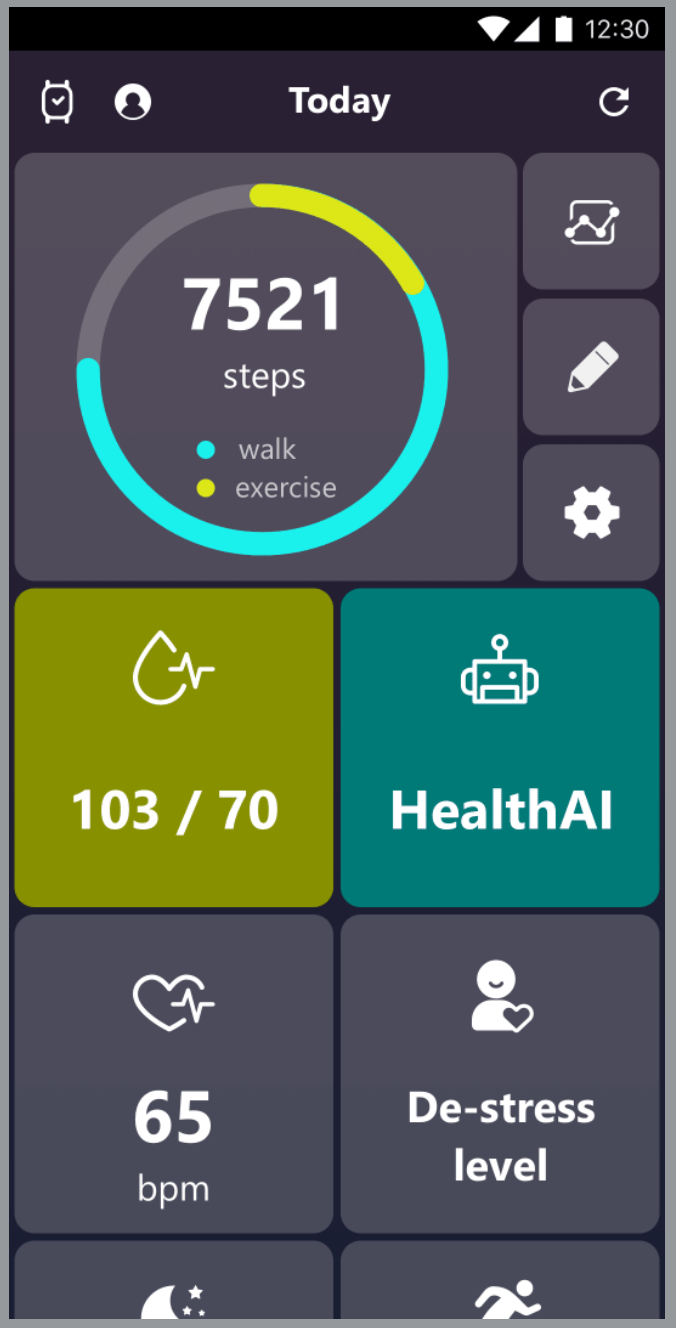
Wearable devices provide real-time and patient-powered data that enable the development of personalized health promotion and management programs. This study aimed to explore the clinical benefits of using the wearable device and to examine associated factors, utilization patterns on health status. 319 community-living adults aged 50-85 years were enrolled and clinically followed for 12 months. Participants were categorized into 3 groups based on the wearable device utilization patterns (active: >30 days of use, non-active: <3 days of use, usual: 3-30 days of use). 128 (40.1%) and 98(30.7%) were active and usual wearable device users, and no significant differences in the baseline demographic characteristics and functional status were noted across groups. Higher cognitive performance was significantly associated with the wearable device use (OR: 1.3,95%CI: 1.1-1.5, p=0.005). Multivariable linear regression showed that 0.16 m/s increase in walking speed among active users, which was significantly higher than non-active users (p=0.034). Compared to usual users, active users had higher average daily, weekday, and holiday step counts. The walking speed increased for 0.03 m/s when participants walked 1,000 more daily step counts (p=0.020). Active use of wearable devices substantially increased walking speed, which suggested better functional outcomes and survival benefits in the future.

INTRODUCTION

Advanced development of internet telecommunication technologies (ICT) enables clinicians and healthcare professionals to collect real-time information through wearable biosensors that further changes healthcare services and healthy lifestyles. The integration of electronic health records and wearable devices may overwhelmingly modify the disease diagnosis, treatment and care management of clinical conditions. The World Health Organization's Global Observatory recognized the roles of mobile devices in supporting medical and public health practice to collect health data, to support diagnosis, to monitor progress, and to promote health promotion [1]. The advantage of real-time and person-powered data nature of wearable devices promotes integration of daily lifestyle conditions in disease diagnosis, health promotion, and personalized care planning that echoes the concepts of precision medicine [2, 3].

Although a great variety of parameters have been developed to measure health, the usual walking speed is a well-established and widely-recognized biomarker to





Chen LY, et al. Aging (Albany NY). 2022;14(3):1280-1291

www.aging-us.com AGING 2022, Vol. 14, No. 3

Research Paper

Predicting neuropsychiatric symptoms of persons with dementia in a day care center using a facial expression recognition system

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ABSTRACT

Background: Behavioral and psychological symptoms of dementia (BPSD) affect 90% of persons with dementia (PwD), resulting in various adverse outcomes and aggravating care burdens among their caretakers. This study aimed to explore the potential of artificial intelligence-based facial expression recognition systems (FERS) in predicting BPSDs among PwD.

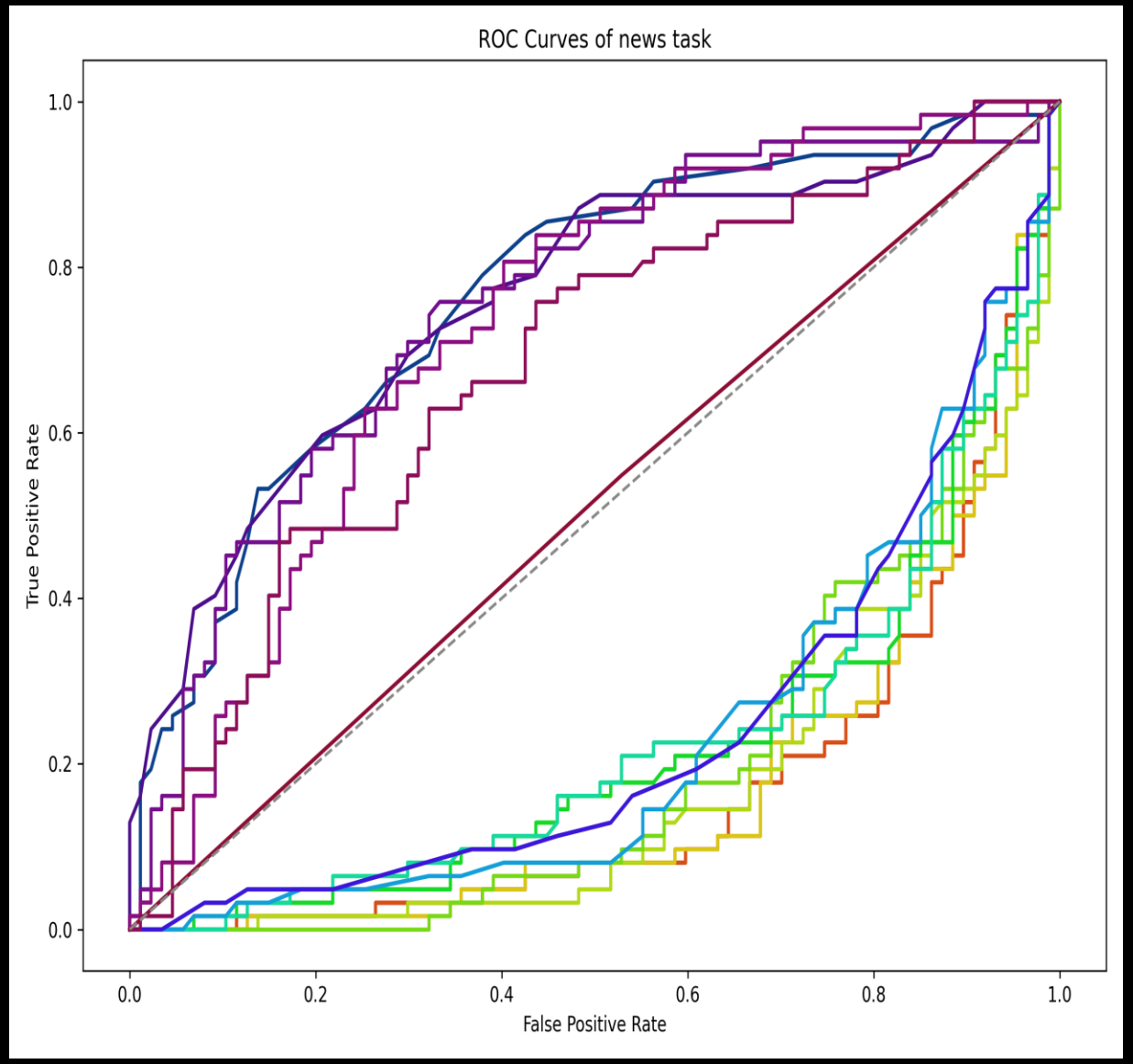
Methods: A hybrid of human labeling and a preconstructed deep learning model was used to differentiate basic facial expressions of individuals to predict the results of Neuropsychiatric Inventory (NPI) assessments by stepwise linear regression (LR), random forest (RF) with importance ranking, and ensemble method (EM) of equal importance, while the accuracy was determined by mean absolute error (MAE) and root-mean-square error (RMSE) methods.

Results: Twenty-three PwD from an adult day care center were enrolled with ≥ 11,500 FERS data series and 38 comparative NPI scores. The overall accuracy was 86% on facial expression recognition. Negative facial expressions and variance in emotional switches were important features of BPSDs. A strong positive correlation was identified in each model (EM: r = 0.834, LR: r = 0.821, RF: r = 0.798 by the patientwise method; EM: r = 0.891, LR: r = 0.870, RF: r = 0.886 by the MinimPy method), and EM exhibited the lowest MAE and RMSE.

Conclusions: FERS successfully predicted the BPSD of PwD by negative emotions and the variance in emotional switches. This finding enables early detection and management of BPSDs, thus improving the quality of dementia care.

INTRODUCTION

Behavioral and psychological symptoms of dementia (BPSDs), or neuropsychiatric symptoms, affect 90% of persons with dementia (PwD) over the course of their illness and are associated with greater morbidity, mortality, and distress between caretakers and their family members [1, 2]. BPSDs may present in 50–60%



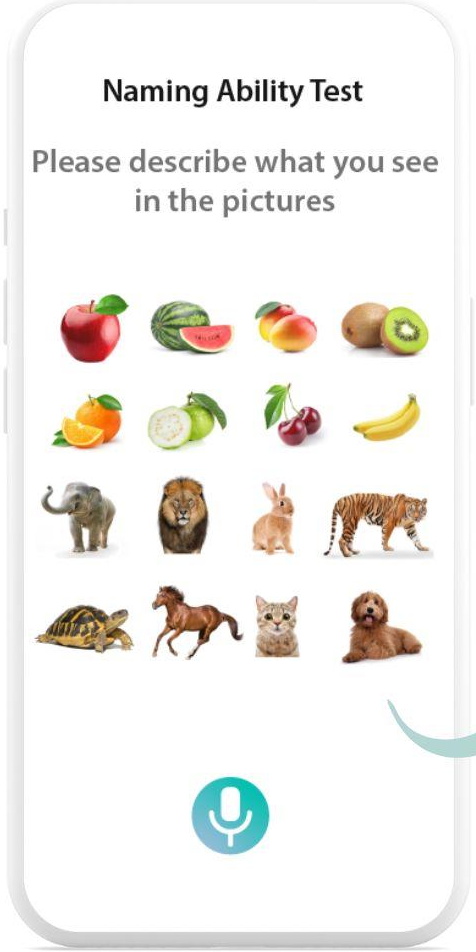
Peng LN, et al. (unpublished data)

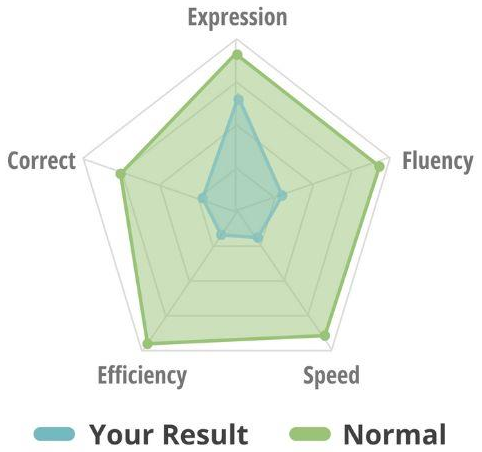
AI Digital Biomarker Assessment

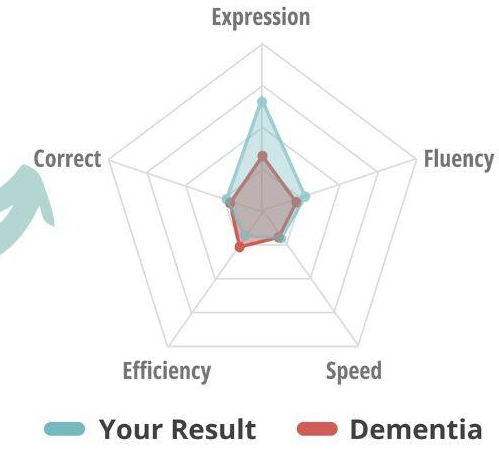
- Early Detection for Cognitive Well-being with AI-

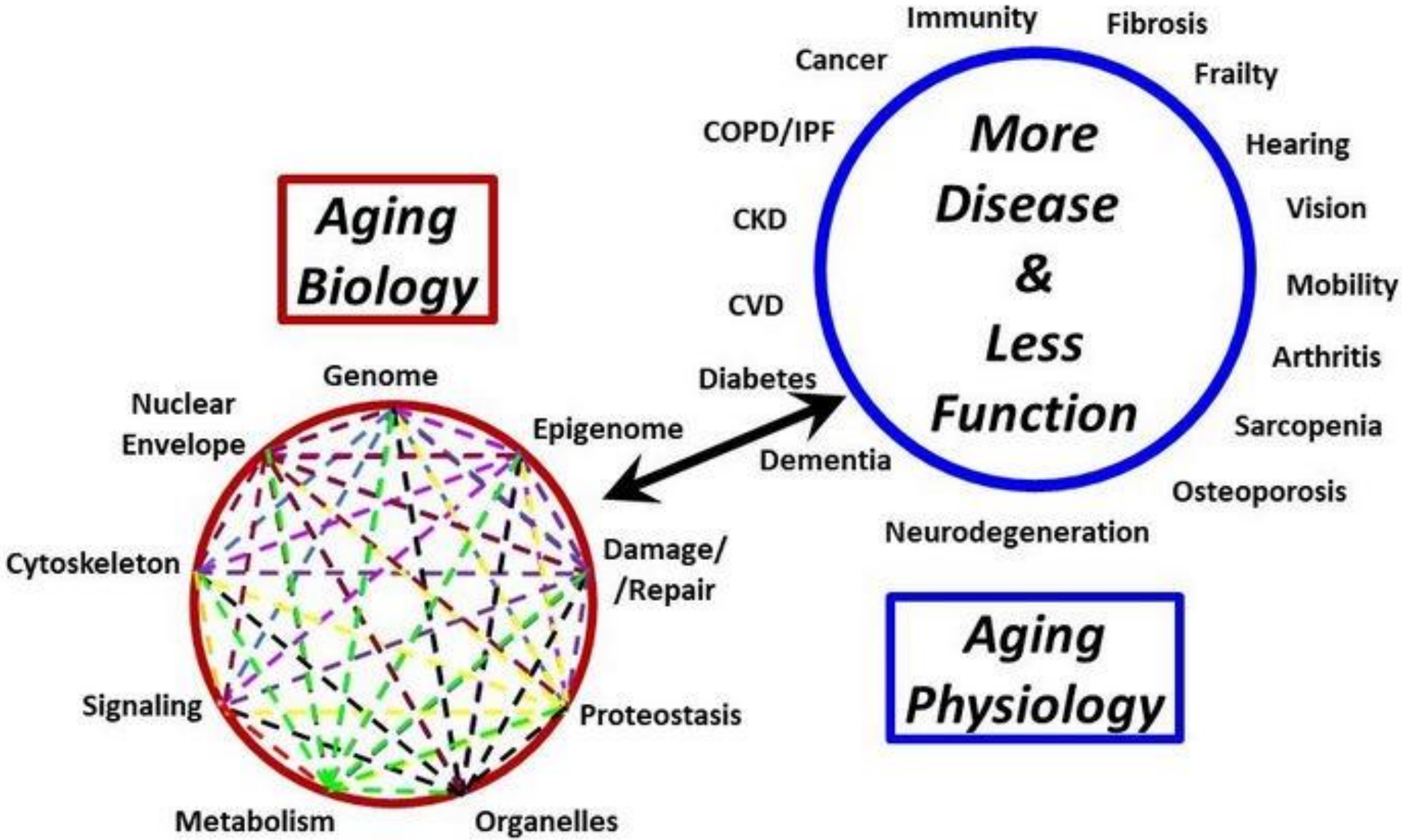
1. Identify subtle differences and detect early signs of cognitive decline.

2. Multifactorial numerical results for easy tracking and comparison.



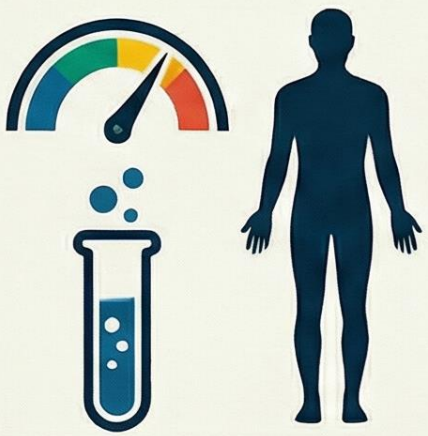





Aging Biology
Genome
Nuclear Envelope
Epigenome
Cytoskeleton
Damage/ /Repair
Signaling
Proteostasis
Metabolism
Organelles
Immunity
Fibrosis
Cancer
Frailty
COPD/IPF
Hearing
CKD
Vision
CVD
Mobility
Diabetes
Arthritis
Dementia
Sarcopenia
Osteoporosis
Neurodegeneration
More Disease & Less Function
Aging Physiology

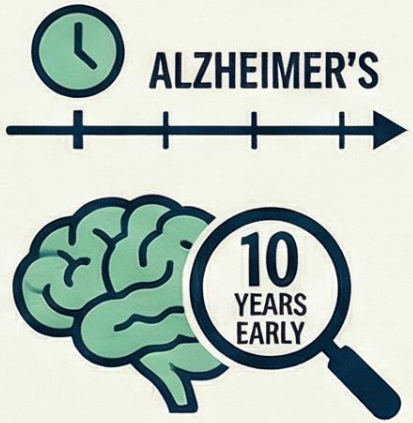
BIOMARKERS: DECODING YOUR BODY'S BIOLOGICAL SIGNALS

1. MEASURABLE INDICATORS



Objective signs—like blood pressure, proteins, or genes—that show how a body functions or responds to treatment.

2. VITAL FOR EARLY DETECTION IN AGING



In aging sciences, biomarkers like **gait speed or amyloid plaques** can **detect Alzheimer's a decode before cognitive symptoms** appear.

3. DIGITAL TOOLS PROVIDE CONTINUOUS HEALTH MONITORING

Digital biomarkers from wearables track real-time data (like sleep or movement) outside of traditional clinic settings.

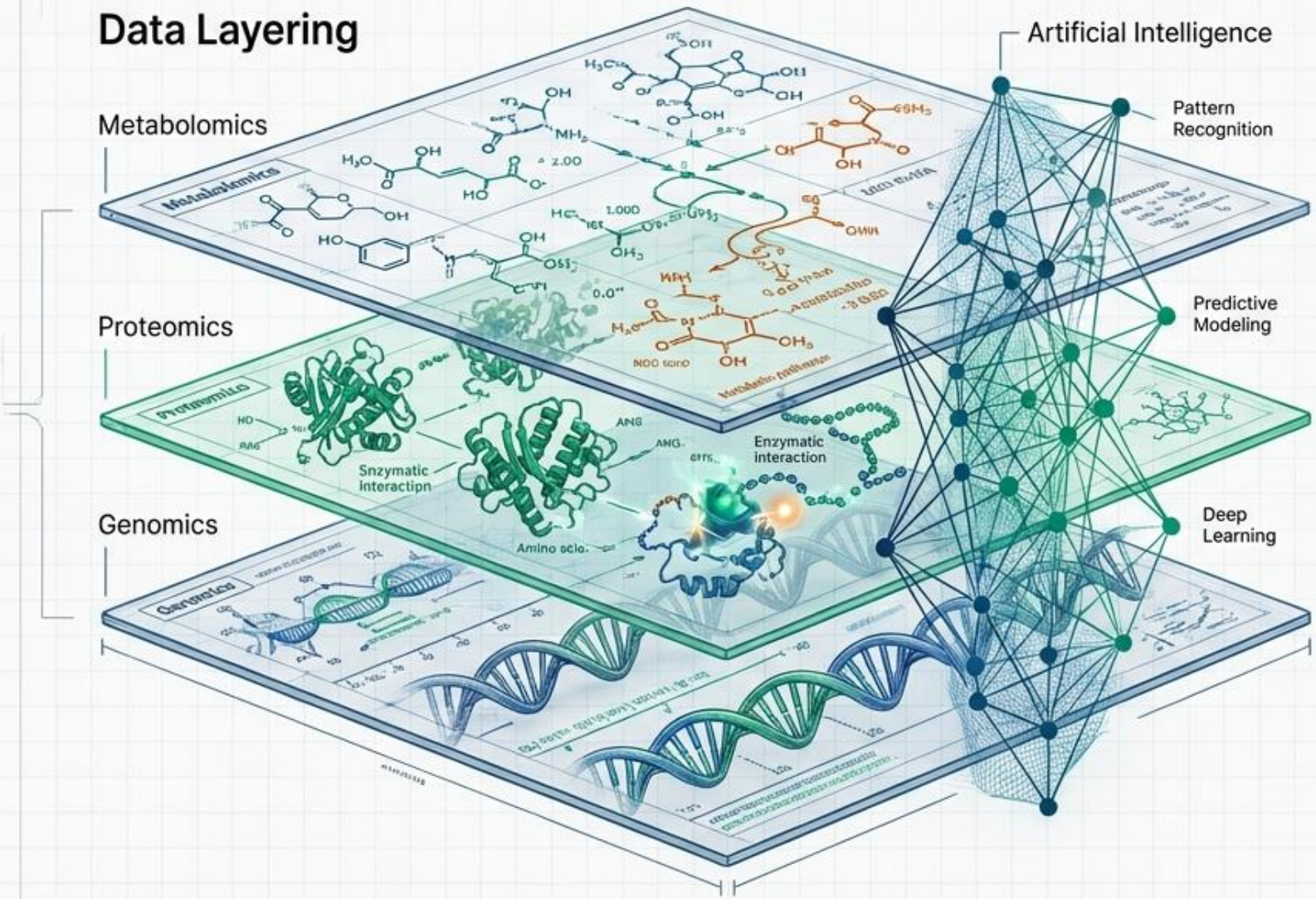
4. PRECISION MEDICINE THROUGH PREDICTIVE SIGNALS

Predictive biomarkers identify **which specific patients will benefit most from a particular therapy** based on their unique molecular profile.

5. SOLVING THE 90% DRUG FAILURE RATE

Since **9 out of 10 drugs fail in clinical trials, better biomarkers provide early warnings on toxicity** to accelerate safe treatments.

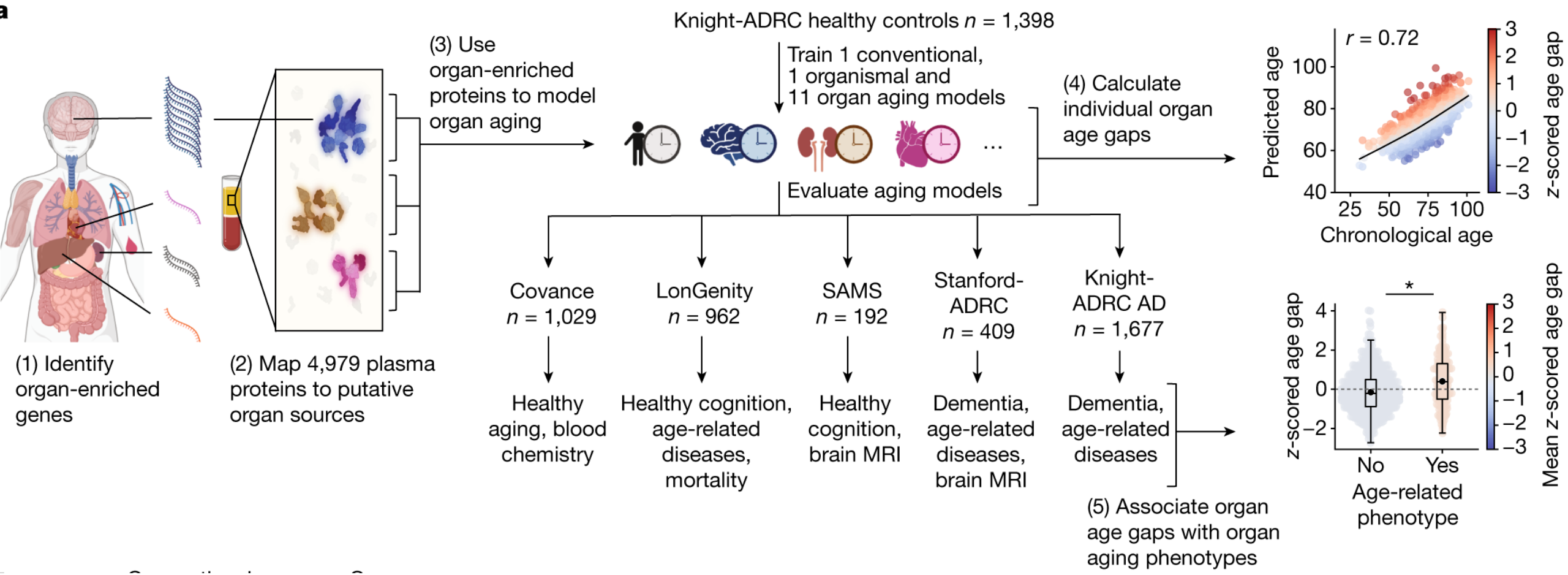
Future Directions: Multi-Omics and AI Integration



Moving from treating disease to preventing decline.

- Holistic Multi-Omics View
- AI Pattern Recognition
- Cost Reduction & Democratization

Proteomic Biological Age



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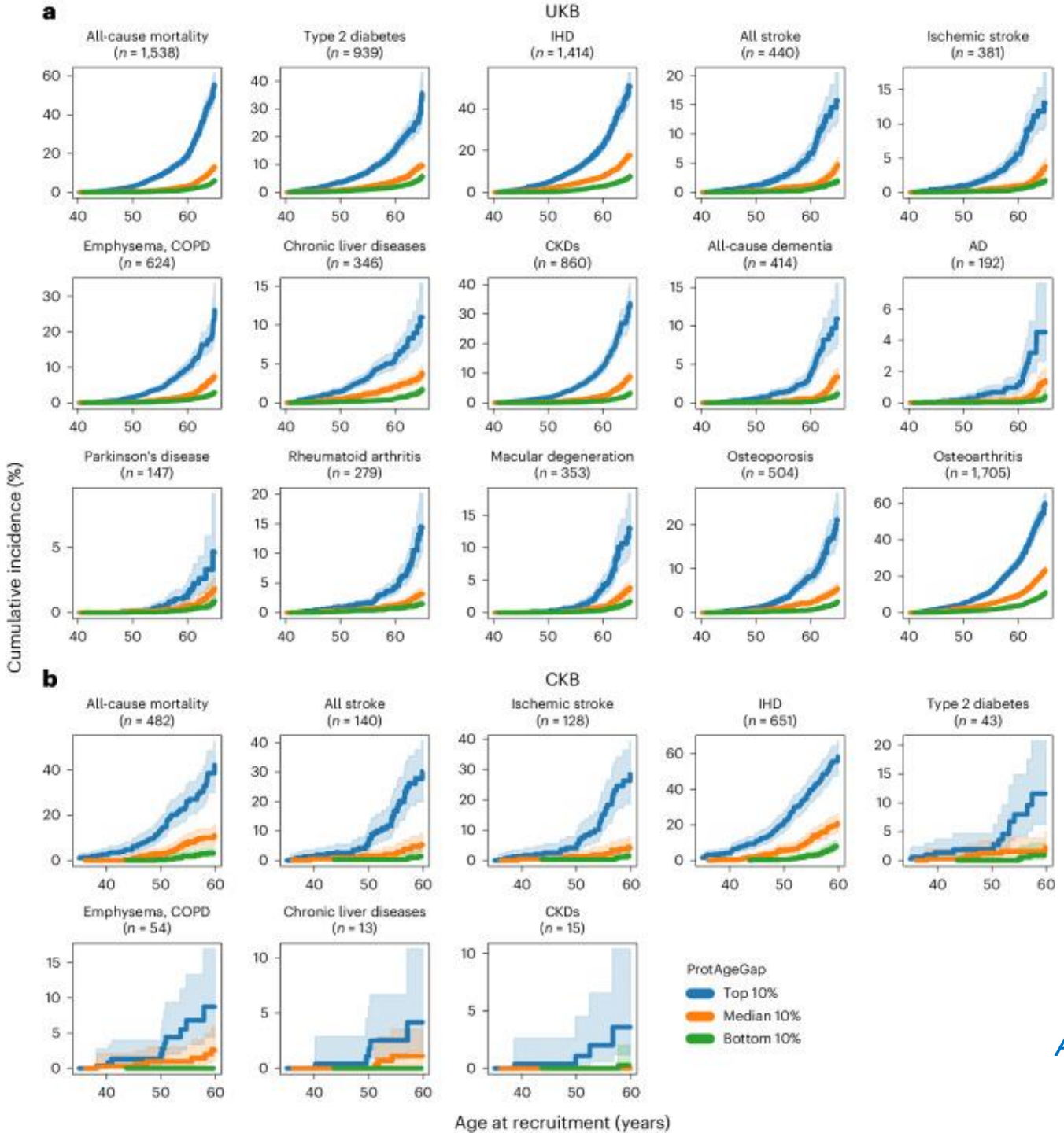
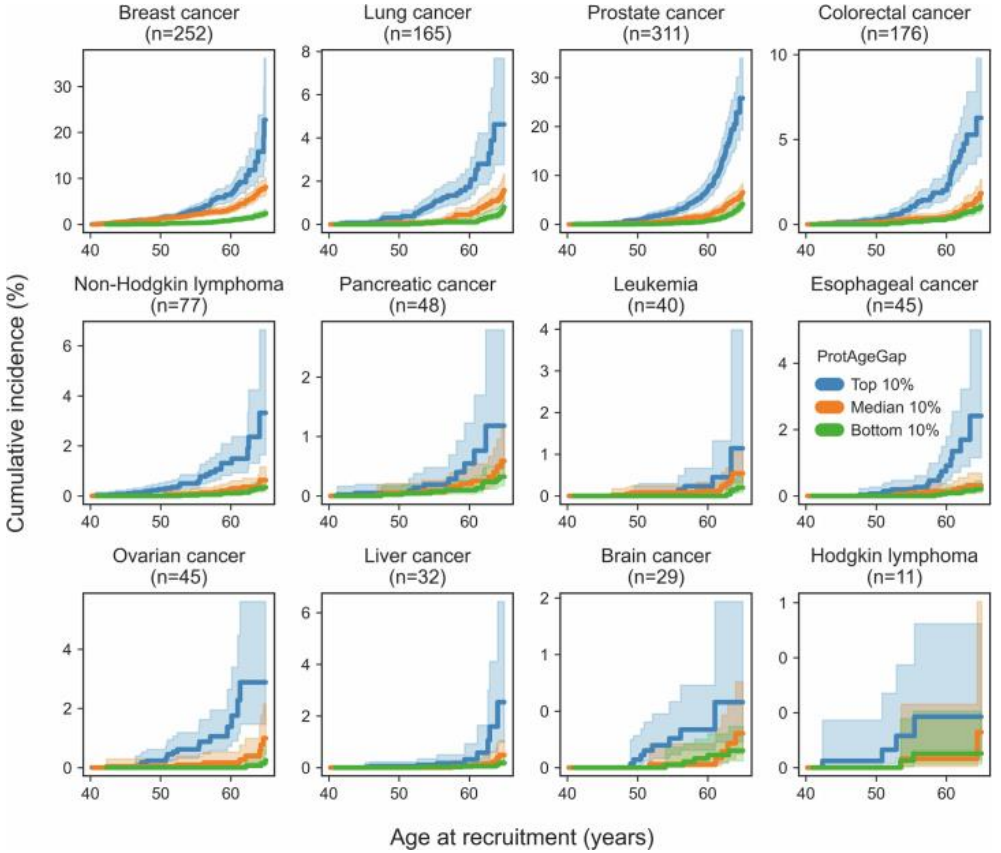
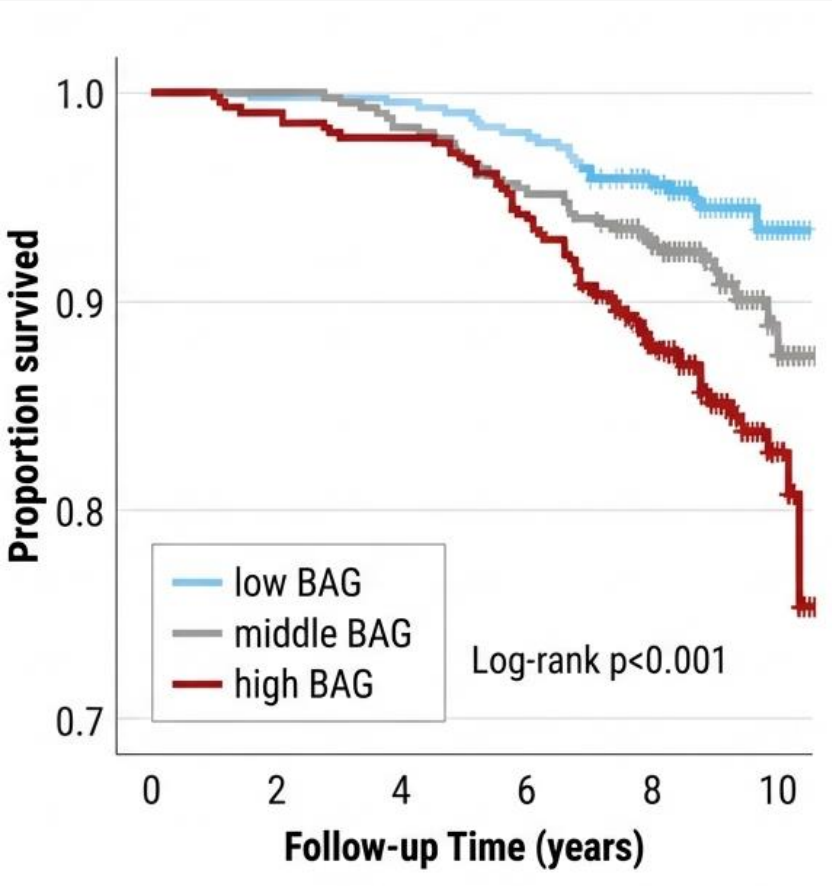


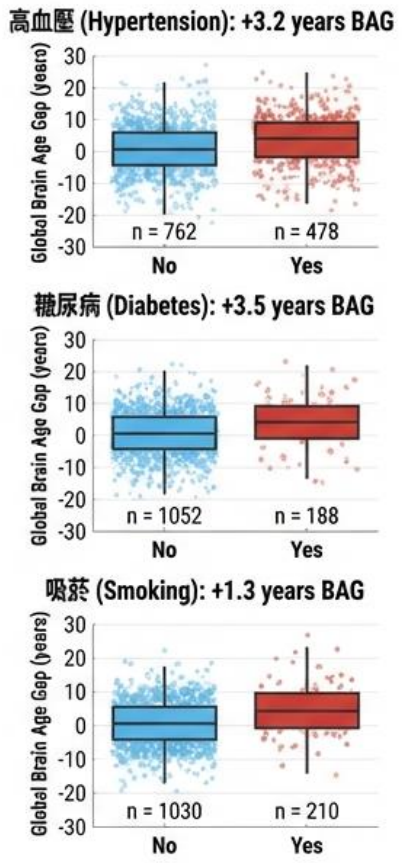


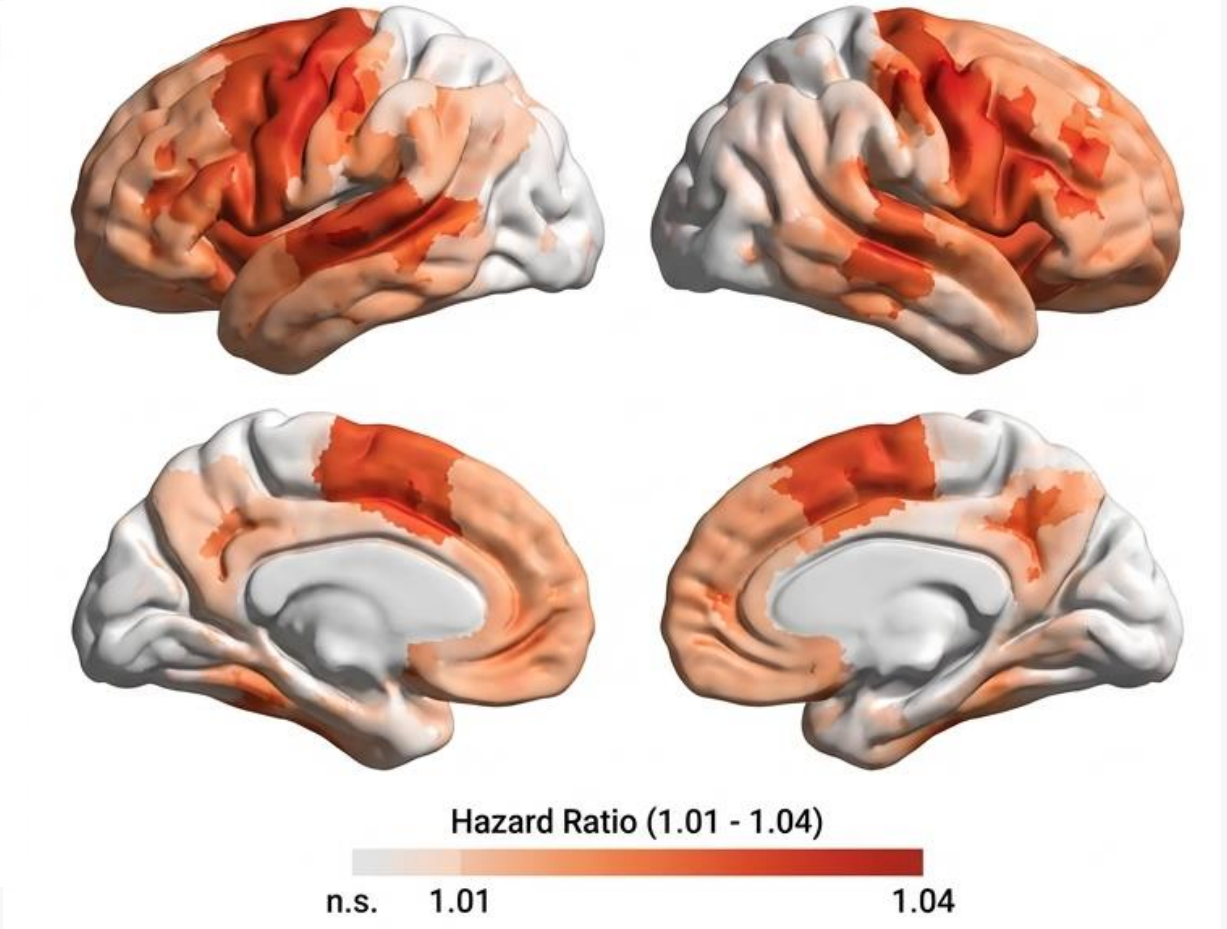
Predicting most chronic conditions and cancers

Argentieri MA, et al. Nat Med. 2024;30(9):2450-2460

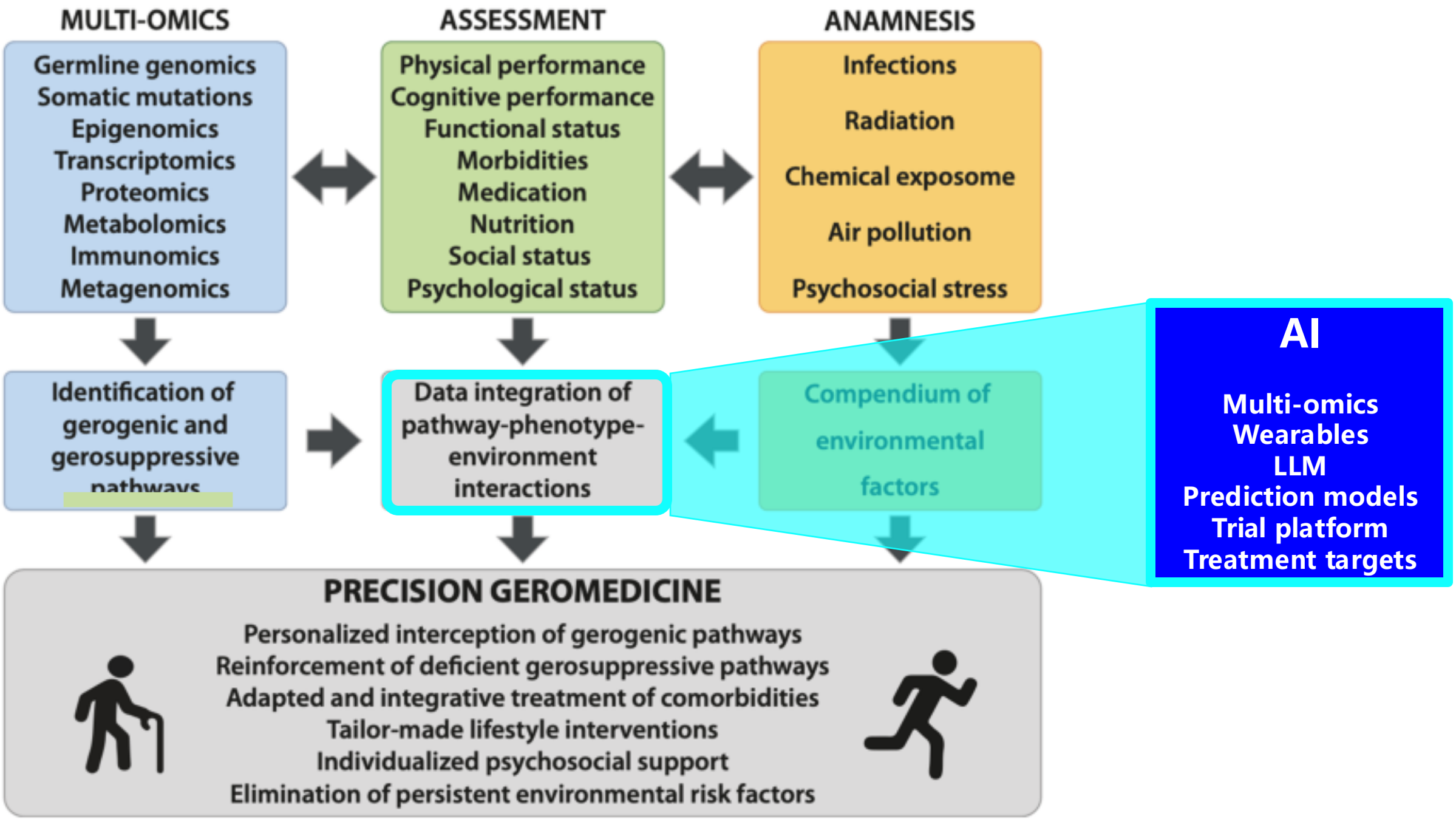
Structural Brain Age Gap







Lee PL, et al, Nat Aging (under review)



López-Otín C, et al. Cell Res. 2024;34(7):463-466

Metformin: Turning Back the Primate Aging Clock

Yang Y, et al. Cell. 2024;187(22):6358-6378.e29.

A Rigorous 40-Month Primate Trial

Adult male cynomolgus monkeys

over 3 years daily treatment (roughly matching 10 human years)

20 mg/kg Standard Dosage
Consistent with standard human Type 2 diabetes management

Proven Safety Profile
No compromise to blood glucose homeostasis, body weight, or blood cell composition

Systemic Biological Rejuvenation

6-Year Regression in Brain Age
Multi-omics analysis showed Metformin-treated brains functioned and appeared biologically 6 years younger

Biological Age Reduction (Years):

Plasma ProteinAge	-6.41
Brain (Frontal Lobe) DNAmAge	-6.10
Lung DNAmAge	-5.11
Liver DNAmAge	-3.95
Kidney DNAmAge	-4.90

Reduced biological age across 13 tissues, including liver, lungs, kidneys, and skeletal muscle

Preservation of the Frontal Lobe
MRI & histological scans revealed preserved cortical thickness in frontal lobe, critical for memory & learning

Cognitive and Structural Impacts

Enhanced Cognitive Performance

Significantly higher accuracy in memory retention, object discrimination, & object reversal learning tasks

Cellular Hallmarks Mitigated

Reduced senescence (p21+)

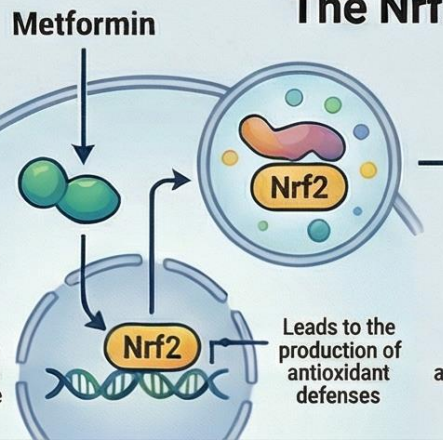
Decreased tissue fibrosis

Lowered chronic inflammation markers

Rebuilding the Myelin Sheath

Metformin helped rebuild thickness of myelin sheath, which typically degrades

The Nrf2 Mechanism



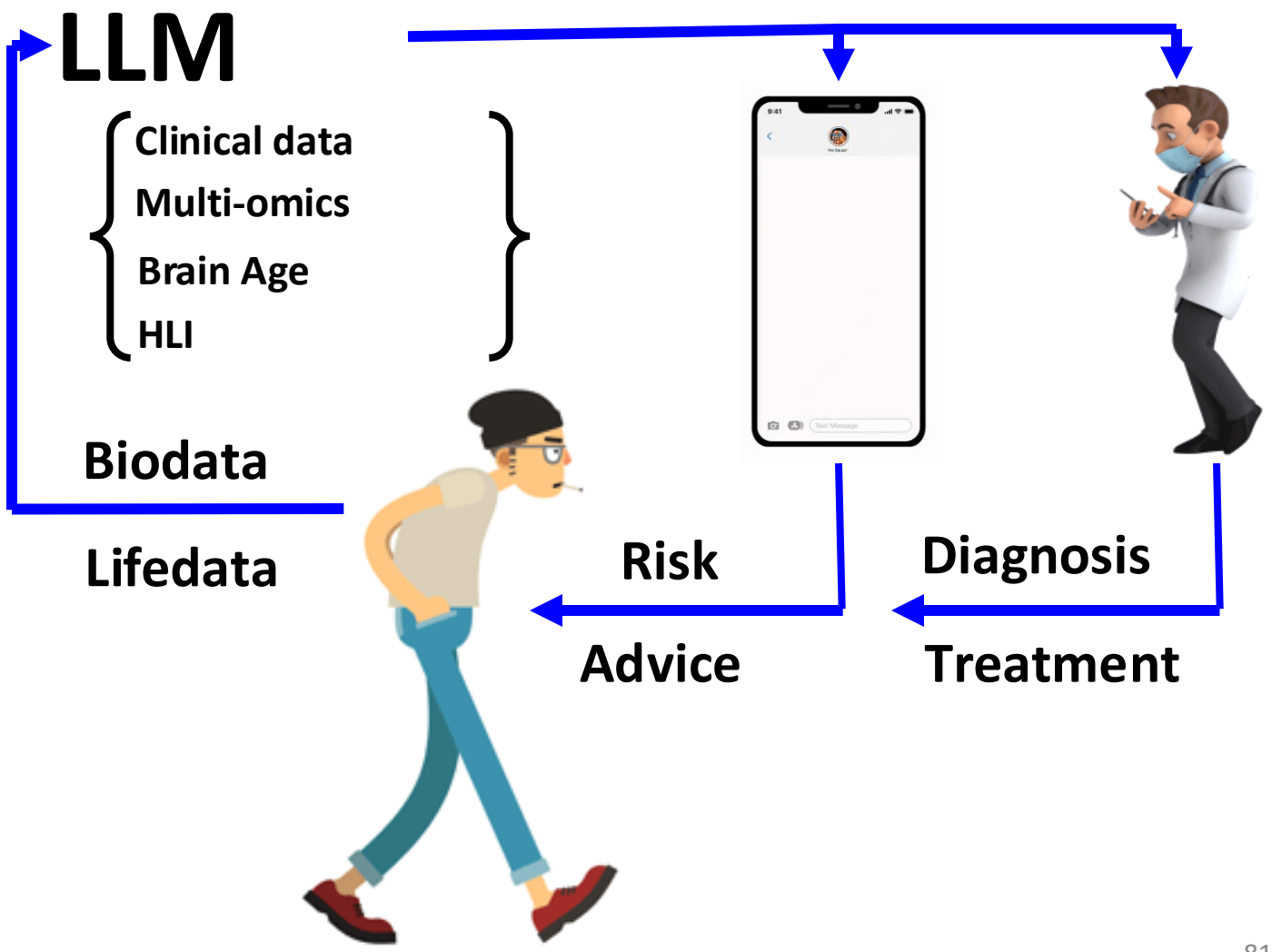
Nrf2 Pathway Activation
Metformin triggers Nrf2, a transcription factor that regulates antioxidant response

Leads to the production of antioxidant defenses

Cell-Autonomous Neuroprotection
In vitro human neuron models confirmed Nrf2 activation is essential to stall neuronal senescence

Reduced Oxidative Damage
Treated tissues showed lower levels of 4 HN2 (lipid peroxidation marker) and reactive oxygen species (ROS)

LLM & GenAI-Powered Healthy Longevity



Multi-Omics Health Analysis

Decode Your Biological Age with ϕ-Bias Technology

從分子層次到可執行的健康洞察，精準評估您的生理年齡與健康偏移

開始新的健康評估 →

了解 ϕ-Bias 模型


Thank You
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