Associations between undernutrition and healthcare utilisation and costs in community-dwelling adults: A longitudinal observational study

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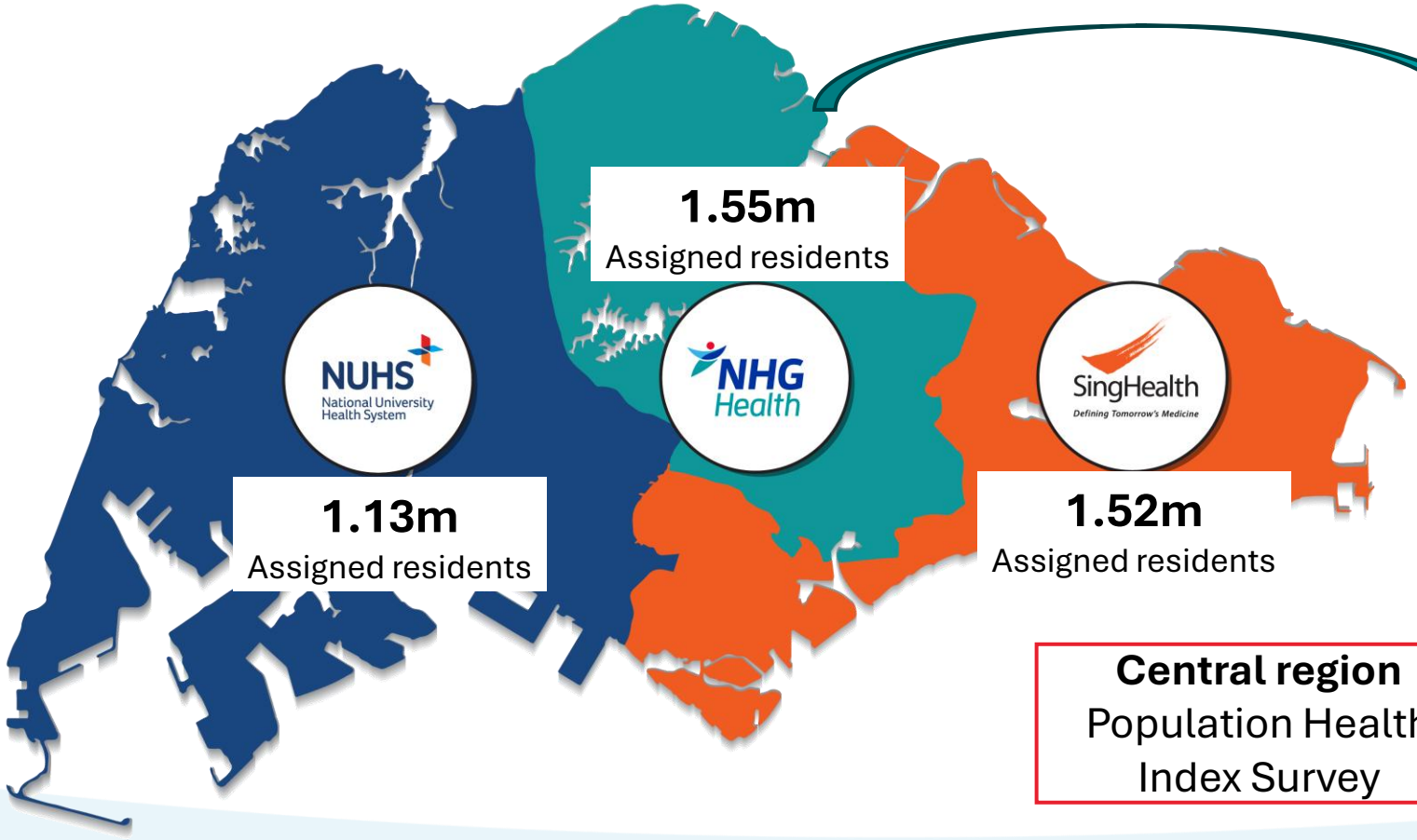
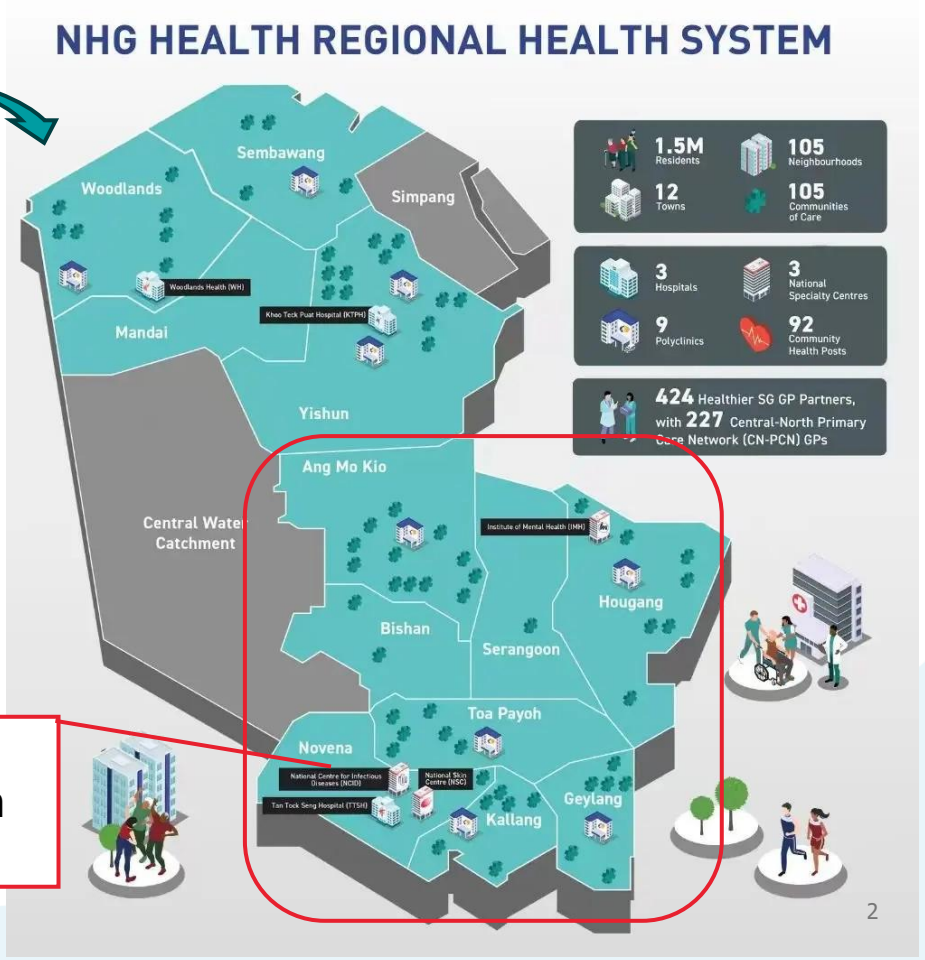
Singapore's public healthcare system since 2017

Singapore's public healthcare system is geographically structured and managed by 3 healthcare clusters, which provide direct services across the full care spectrum, including primary care, acute and specialist care, as well as intermediate and long-term care.



Central region
Population Health Index Survey



Background

Undernutrition: A Persistent Public Health Challenge

Despite economic progress and global commitments to improve nutrition, malnutrition or its risk remains a major public health challenge worldwide, particularly among older adults.

Most countries are off-track in meeting global targets for reducing diet-related non-communicable diseases [1].

1.2% - 52.5%

Global prevalence of undernutrition (by MNA) among older adults [2-4]

Impacts of Undernutrition on health and well-being

- Accelerated muscle and bone loss → function decline
- Increased risk of falls and fractures
- Mobility limitations and loss of independence
- Higher healthcare utilisation and costs

Singapore's Context:

- A rapidly ageing population faces growing but often overlooked risk of undernutrition
- Substantial proportion of community-dwelling adults are at moderate to high risk of undernutrition due to [5-7]:
  - Inadequate nutrient intake
  - Poor appetite
  - Chronic conditions
  - Cognitive impairments

Research Gaps and Study Objectives

Research Gaps

- Scare evidence in younger & middle-aged populations.
- Limited data from multi-ethnic Asia contexts like Singapore.
- Mainly siloed view of healthcare utilisation, lack of holistic investigation.
- Methodological reliance on single time-point assessment without adjusting for pre-existing utilisation patterns.

Study Objective

- To investigate associations between undernutrition and subsequent one-year and five-year healthcare utilisation and costs.

Hypothesis

Undernutrition is associated with elevated healthcare utilisation and costs, manifesting in increased inpatient admissions and ED attendances—with effect magnitudes varying by care settings.

Methods: Study Design, Data Sources, and Participants

Study Design: A retrospective longitudinal observational study

Data Sources

- Baseline Population Health Index Survey data collected from adult residents who provided written consent for data linkage
- Healthcare utilisation and cost data extracted from a centralised healthcare cluster repository (Population Health Data Mart)

↓

Linked using unique identifiers & anonymised

↓

Participants in the study (n=1,703)

Methods: Variables & Statistical Analysis

Outcome Variables

One-year and five-year healthcare utilisation and gross cost data, spanning

Five Clinical Settings:

- Polyclinics (primary care)
- Specialist outpatient clinics (SOCs)
- Emergency departments (EDs)
- Day surgery (DS) centers
- Inpatient wards

Exposure Variable

Nutritional Status:

- Assessed using the 18-item full Mini Nutritional Assessment (MNA®)
- Maximum total score: 30 points, maximum screening score: 14 points
- Undernutrition defined by a total score of < 24, or a screening score of <12

Covariates:

- Age
- Sex
- Ethnicity (C vs non-C)
- Education
- Marital status
- Employment
- Housing type
- Living alone
- Financial adequacy
- Alcohol misuse
- Smoking status
- Chronic conditions

One-year healthcare utilisation preceding baseline survey

Statistical Analysis

√× Two-part models to examine associations between undernutrition and subsequent one-year and five-year healthcare utilisation and costs.

Results: Baseline Characteristics (n=1,703)

mean age
52.5 ± 17.0

36.0%
aged≥60

77.9%
Chinese

54.1%
females

61.3%
married

85.3%
formal education

62.9%
employed

88.9%
not living alone

64.5%
HDB3/4-room

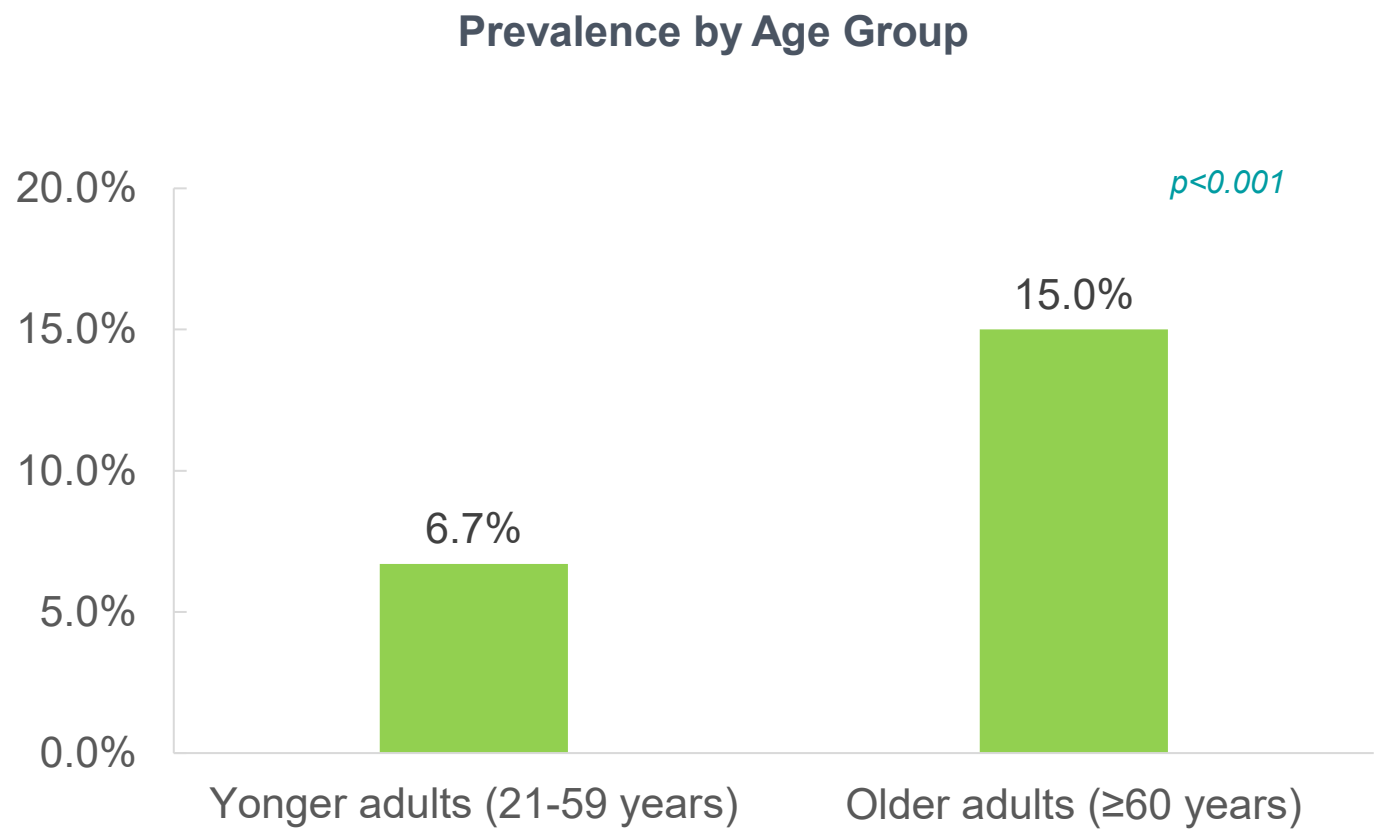
85.1%
financial adequacy

74.0%
never smoked

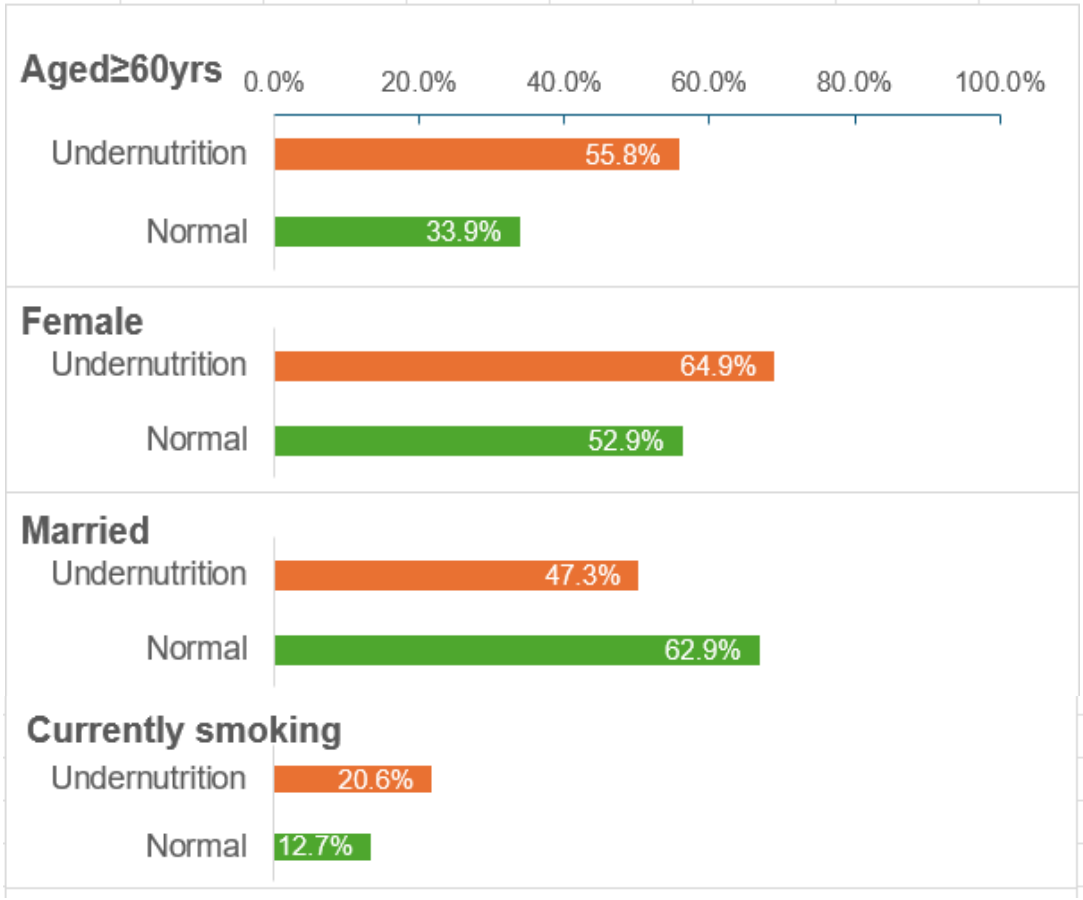
25.6%
alcohol misuse

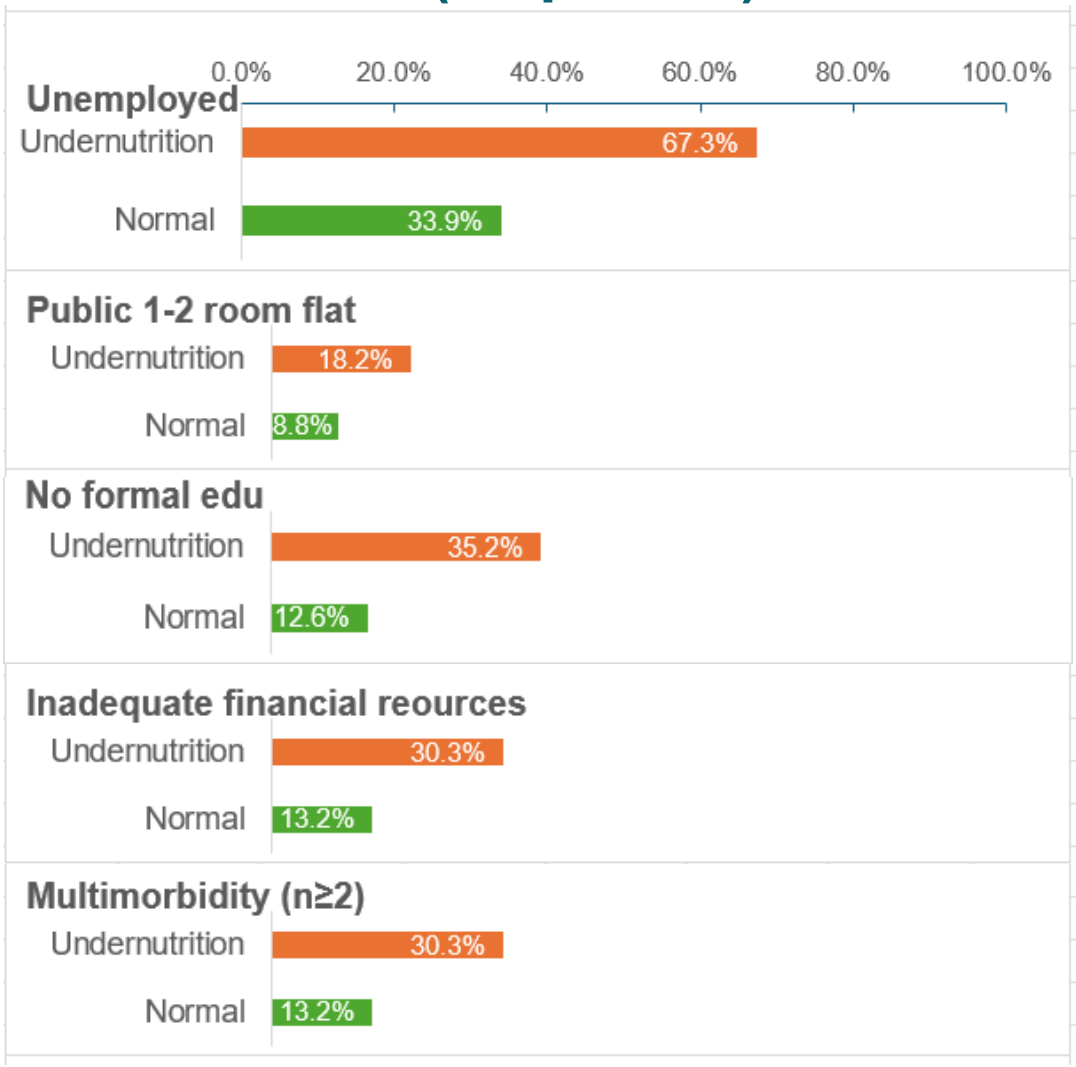
37.3%
≥2 conditions

Undernutrition prevalence was 9.7% (165/1,703) overall and 15% in older adults.



Undernourished individuals were older (mean age 59.1 vs. 51.8 years) & were more likely to be female, unmarried, less educated, unemployed, financially strained, current smokers, & multimorbid (all p<0.05).





Individuals with undernutrition generally had more SOC & ED visits & inpatient admissions

Nutritional status	One-year healthcare utilisation			Five-year healthcare utilisation		
	Mean±SD	Median (Q1-Q3)	p-value	Mean±SD	Median (Q1-Q3)	p-value
	Polyclinic visits					
Normal (n=1538)	1.5 ± 3.9	0 (0, 1)	0.121	8.2 ± 16.6	1 (0, 9)	0.351
Undernutrition (n=165)	2 ± 5	0 (0, 2)		8.5 ± 15.2	1 (0, 11)	
	SOC visits					
Normal (n=1538)	1.3 ± 3.7	0 (0, 0)	0.000	6.8 ± 17.1	0 (0, 5)	0.000
Undernutrition (n=165)	3.2 ± 6.5	0 (0, 3)		12.7 ± 23.6	1 (0, 15)	
	ED visits					
Normal (n=1538)	0.1 ± 0.5	0 (0, 0)	0.000	0.6 ± 1.7	0 (0, 1)	0.000
Undernutrition (n=165)	0.5 ± 1.4	0 (0, 1)		2.1 ± 4.7	0 (0, 2)	
	DS visits					
Normal (n=1538)	0.1 ± 0.3	0 (0, 0)	0.905	0.3 ± 1.4	0 (0, 0)	0.468
Undernutrition (n=165)	0.1 ± 0.4	0 (0, 0)		0.3 ± 1.1	0 (0, 0)	
	Inpatient admissions					
Normal (n=1538)	0.1 ± 0.3	0 (0, 0)	0.000	0.4 ± 1.3	0 (0, 0)	0.000
Undernutrition (n=165)	0.4 ± 0.9	0 (0, 0)		1.5 ± 3.6	0 (0, 1)	

Undernutrition was associated with more inpatient admissions in 1-year

Individuals with undernutrition had an average of 0.1 more inpatient admissions (p = 0.011) and a higher odds of ED visits (OR=1.8, p=0.014) over one year compared to those with normal nutritional status.

One-year healthcare utilisation	Normal nutritional status Mean (95% CI)	Undernutrition Mean (95% CI)	Average Difference Mean (95% CI)	P-value	Remarks
Polyclinic visits	1.61 (1.44, 1.79)	1.42 (1.1, 1.7)	-0.19 (-0.47, 0.10)	0.198	OR:1.05, p=0.840
SOC visits	1.59 (1.36, 1.82)	1.61 (1.22, 1.99)	0.01 (-0.42, 0.44)	0.951	OR:1.18, p=0.501
ED visits	0.16 (0.13, 0.19)	0.24 (0.17, 0.32)	0.08 (-0.01, 0.17)	0.075	**OR:1.76, p=0.014**
DS	0.07 (0.05, 0.08)	0.07 (0.02, 0.12)	0.002 (-0.05, 0.05)	0.930	OR=0.77, p=0.498 Marginally more among users
Inpatient admissions	0.08 (0.06, 0.10)	0.17 (0.10, 0.23)	**0.09** (0.02, 0.16)	**0.011**	**OR: 2.43, p=0.002**

All results were adjusted for age group, female, Chinese, marital status, formal education, living alone, perceived financial adequacy, smoking status, alcohol misuse, number of chronic conditions, and corresponding baseline healthcare utilisation.

Undernutrition was associated with higher one-year inpatient costs

Individuals with undernutrition incurred S$799.1 more one-year inpatient costs compared to those with normal nutritional status (p=0.021).

1SGD~0.7776USD

One-year healthcare expenditure (S$)	Normal nutritional status Mean cost (95% CI)	Undernutrition Mean cost (95% CI)	Average Difference Mean cost (95% CI)	P-value	Remarks
Polyclinic visits	246.07 (194.82, 297.33)	221.38 (159.23, 283.53)	-24.69 (-70.49, 21.10)	0.291	
SOC visits	527.54 (153.44, 1001.64)	612.65 (62.85, 1162.44)	85.10 (-109.68, 279.89)	0.392	
ED visits	38.72 (30.66, 46.78)	43.29 (22.84, 63.74)	4.57 (-17.95, 27.10)	0.691	
DS	96.94 (69.90, 123.98)	115.75 (7.70, 223.80)	18.81 (-93.01, 130.62)	0.742	
Inpatient admissions	459.29 (273.37, 645.20)	1258.41 (618.66, 1898.15)	**799.12** (122.93, 1475.32)	**0.021**	Higher odds

All results were adjusted for age group, female, Chinese, marital status, formal education, living alone, perceived financial adequacy, smoking status, alcohol misuse, number of chronic conditions, and corresponding baseline healthcare utilisation.

Undernutrition was associated with more inpatient admissions in five years

Individuals with undernutrition had 0.3 more inpatient admissions (p = 0.018) but 2.4 fewer Polyclinic visits (p =0.007) over five years compared to those with normal nutritional status.

Five-year healthcare utilisation	Normal nutritional status Mean (95% CI)	Undernutrition Mean (95% CI)	Average Difference Mean (95% CI)	P-value	Remarks
Polyclinic visits	9.60 (8.38, 10.83)	7.22 (5.46, 8.98)	**-2.38** (-4.11, -0.65)	**0.007**	OR: 0.98, p=0.912 Fewer among users
SOC visits	9.30 (7.36, 11.24)	7.41 (5.29, 9.53)	-1.89 (-4.03, 0.24)	0.082	OR:1.02, p=0.938
ED visits	0.75 (0.66, 0.85)	1.01 (0.72, 1.29)	0.25 (-0.05, 0.55)	0.100	OR:1.29, p=0.216
DS	0.32 (0.25, 0.38)	0.22 (0.12, 0.32)	-0.10 (-0.2, 0.03)	0.126	OR: 0.89, p=0.643
Inpatient admissions	0.44 (0.38, 0.51)	0.75 (0.50, 0.99)	**0.30** (0.05, 0.55)	**0.018**	**OR: 1.62, p=0.035** marginally more among users

All results were adjusted for age group, female, Chinese, marital status, formal education, living alone, perceived financial adequacy, smoking status, alcohol misuse, number of chronic conditions, and corresponding baseline healthcare utilisation.

Undernutrition was associated with higher ED cost in five years

1SGD~0.7776USD

Individuals with undernutrition incurred S$460.7 less in primary care cost (p=0.008) and S$140.3 more in ED cost (p=0.034) over five years compared to those with normal nutritional status

Five-year healthcare expenditure (S$)	**Normal nutritional status** Mean (95% CI)	**Undernutrition** Mean (95% CI)	**Average Difference** Mean (95% CI)	P-value	Remarks
Polyclinic visits	1643.91 (1156.50, 2131.33)	1183.18 (751.65, 1614.70)	**-460.74** (-800.62, -120.85)	**0.008**	Lower among users
SOC visits	13935.82 (-13229.45, 41101.08)	9214.30 (-8852.35, 27280.94)	-4721.52 (-14510.54, 5067.49)	0.344	Lower among users
ED visits	269.51 (234.04, 304.97)	409.80 (284.47, 535.12)	**140.29** (10.40, 270.18)	**0.034**	Higher among users
DS	439.04 (354.80, 523.29)	318.50 (153.22, 483.77)	-120.55 (-308.81, 67.72)	0.742	
Inpatient admissions	3902.26 (3007.47, 4797.04)	5036.94 (3166.35, 6907.53)	1134.68 (-972.04, 3241.40)	0.291	Higher odds

All results were adjusted for age group, female, Chinese, marital status, formal education, living alone, perceived financial adequacy, smoking status, alcohol misuse, number of chronic conditions, and corresponding baseline healthcare utilisation.

Key Findings

- Undernutrition prevalence was **9.7%** overall and significantly higher in older adults (**15.0%**) than younger adults (6.7%), although multivariate analysis revealed that older age itself was not an independent factor.

- Compared to those with normal nutritional status, individuals with undernutrition had

	Over one year	Over five years
Utilisation	**IP: doubled (0.2 vs 0.1)** **ED: 80% higher odds**	**IP: 0.3 more (0.7 vs 0.4)** Polyclinic visits: 2.4 fewer (7.2 vs 9.6)
Cost	**IP: S$799.1 more**	**ED: S$140.3 more** Polyclinics: S$460.7 less IP: S$1,134.68 more (n.s.)

Limitations

- Residual confounding (e.g., unmeasured factors like social support) may influence the observed associations.
- Reliance on self-reported MNA scores may introduce reporting bias while consent-based data linkage could introduce selection bias.
- The utilisation data captured in this study were limited to one healthcare cluster and did not include utilisation incurred outside NHG Health, potentially underestimating the total burden of undernutrition.
- Finally, generalisability to other Asian populations warrants further verification, and the observational nature of the study precludes causal inference.

Conclusion

Among community-dwelling adults in Singapore, undernutrition was associated with **increased average inpatient admissions** over both one year and five years, and **higher odds of ED visits** over one year. This translated to increased costs for inpatient admissions and more ED expenditure but less in primary care settings over five years.

Future studies

- Reconfirm the associations using national-level data
- Conduct rigorous intervention studies (e.g., natural experiments / quasi-experimental studies leveraging policy changes or randomised controlled trials of targeted nutrition interventions among community-dwelling adults) to strengthen causal inference about the relationship between nutritional status and healthcare utilisation.

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Thank You

Tan Tock Seng Hospital • Khoo Teck Puat Hospital • Woodlands Health • Yishun Community Hospital • TTSH Integrated Care Hub

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