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ORIGINAL ARTICLE

Knowledge of lifespan and healthspan and interest in Healthy Longevity Medicine among the general population in Singapore: the Singapore HEalthy LOngevity (HELO) survey

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Abstract Given the growing global interest in Healthy Longevity Medicine (HLM), the field lacks understanding about public knowledge and interest, which are crucial for any public health intervention relying on HLM. This study presents findings from the Healthy Longevity (HELO) survey conducted in Singapore, assessing public knowledge regarding lifespan (number of years a person is alive), healthspan (number of years a person spends in good health), and interest in HLM. This nationwide cross-sectional survey, conducted between June and August 2024, involved 3034 participants. Main domains including questions on demographics, living arrangements, medical information, health behaviours, income and financial status were tested for associations with knowledge about lifespan and healthspan, and interest in HLM clinics using binary logistic regression. While 82.3% of 46 years old [IQR, 34–59] participants correctly defined lifespan, 41.3% accurately defined healthspan and 55.5% expressed interest in HLM clinics. Younger age, male gender,

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Chinese ethnicity, higher education and income, full-time employment, lower body mass index, supplement use, moderate (vs. no) alcohol consumption, high exercise frequency and enrolment in (self-paid) annual health screenings were associated with better knowledge and stronger interest in HLM clinics. These findings highlight the need for targeted education to enhance understanding of healthspan and implement evidence-based preventive health programmes, supporting the clinical translation of geroscience into Precision Geromedicine through HLM clinics.

Keywords Ageing · Healthspan · Knowledge · Lifespan · Longevity · Motivation

Introduction

The shift toward ageing populations globally has placed unprecedented pressure on healthcare systems [1]. As the older demographic grows, healthcare costs are expected to increase, raising significant concerns about long-term sustainability [2]. In Singapore, where the proportion of individuals aged 65 years and older is projected to exceed 25% by 2030, this demographic shift has also been accompanied by a growing prevalence of ageing-related diseases [3]. These trends, coupled with rising old-age dependency ratios and declining birth rates [4], pose challenges to healthcare systems to deliver quality and sustainable care. Ageing is a process influenced by various psychological factors, including ageism and self-perceptions of ageing, which may affect physical, mental, and social well-being [5]. Ageing is therefore more than disease prevalence and should be approached positively to modulate and preserve healthspan.

Healthy Longevity Medicine (HLM), also referred to as Precision Geromedicine for scientific and medical audiences, is an emerging medical speciality and offers promising solutions to address the challenges posed by ageing populations [6]. Rooted in geroscience, Precision Geromedicine seeks to optimise health and healthspan by targeting the biological processes of ageing [6]. By focusing on prevention and delaying the onset of ageing-related diseases, the field offers a paradigm shift from reactive to proactive healthcare [7].

Despite its promise, public opinions on HLM remain insufficiently understood, with surveys revealing diverse preferences as well as socio-demographic and ethical considerations, highlighting the complexity of perspectives on health, lifespan and healthspan [8, 9]. Lifespan refers to the "total duration of a person's life, from birth to death, which increases over time" [10]. Although there is no universally accepted definition of healthspan, it is most commonly described as the "period of life spent in good health" [11, 12].

The Healthy Longevity (HELO) consortium was established to examine public awareness, knowledge, and motivations towards healthy longevity [13]. The HELO conceptual framework was developed to explore factors shaping views and intentions towards healthy longevity, which formed the basis for the global HELO population survey, first developed and deployed in Singapore [13]. Understanding public knowledge and interest in Singapore is particularly timely, given its large-scale national efforts to ramp up preventive healthcare [6] and its population's general receptiveness to public health campaigns [14]. The HELO survey aims to provide guidance for the integration of geroscience into new models of healthy longevity medicine care through national policy and preventive health strategies [15]. A preliminary qualitative study conducted with the Singaporean population during the development of the HELO survey highlighted mixed reactions to the notion of HLM clinics, with both enthusiasm about their potential to extend healthspan but also reservations regarding the extent of lifestyle changes required to reach positive results [16]. However, this study could not inform on the representativeness of these different perspectives in the Singaporean population given its qualitative nature. A population survey is hence warranted to obtain national population estimates and quantify their variation with individual characteristics.

This study analysed data from the HELO population survey in Singapore to examine knowledge of lifespan and healthspan, assess interest in attending HLM clinics, and evaluate whether demographic, socioeconomic, and lifestyle factors were associated with these outcomes.

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Method

Ethics approval for the study was obtained from the Institutional Review Board at the National University of Singapore (NUS-IRB-2023-672). Written or electronic informed consent was obtained from all participants prior to data collection.

Study design and sampling

A nationwide cross-sectional design was utilised to assess public knowledge and interests in HLM through the HELO survey in Singapore [13, 16]. The HELO survey explored public awareness, knowledge, and factors underlying motivation towards lifespan, healthspan, and HLM. The HELO survey comprised 149 questions across multiple sections, designed to capture a comprehensive understanding of participants' demographics, knowledge, behaviours, and attitudes towards HLM:

- Section A: Demographic data (37 questions).
- Section B: Knowledge of lifespan and healthspan (20 questions).
- Section C: Interest in HLM Clinics and health-related concerns (17 questions).
- Section D: Health behaviours, social support, personality, and aspirations (75 questions).

The survey was available in the official languages of Singapore, namely English, Chinese, Malay, and Tamil. All translations followed the Translation, Review, Adjudication, Pretest, and Documentation approach (TRAPD) [17] to ensure culturally and contextually appropriate adaptations.

The survey was administered door-to-door in Singapore from June 24 to August 11, 2024, targeting a sample size of up to $n=2500$ participants. For door-to-door data collection, multistage cluster sampling was used to randomly select postal codes from households and public places across five major regions of Singapore (Central, East, West, North, and Northeast), as defined by the Urban Redevelopment Authority Singapore [18]. This is to ensure a nationally representative sample and capture variations across socio-demographic groups. The "last birthday" method [19] was used for within-household sampling to select household members who were currently at home, aged 21 years old or older (as defined by the local age of majority), and had the most recent birthday. Surveys were conducted daily between 9 am and 9 pm, and participants had the option to complete the survey digitally via a QR code ($n=1614$) or using a pen-and-paper format ($n=389$). For online data collection, surveys were administered via the Qualtrics platform, which recruited participants residing in Singapore. A total of $n=1000$ participants were recruited through Qualtrics from July 8 to August 20, 2024. Stratified random sampling was applied to ensure demographic representativeness across age, gender, and ethnicity.

The median time (seconds) taken to complete the surveys was 1546 [IQR, 993–2221] for the door-to-door survey and 971 [IQR, 743–1506] for the online survey.

Participants

Eligible participants were adults aged 21 years and older residing in Singapore. Door-to-door participants received a S$20 reimbursement for their time and effort. Online panel participants were remunerated based on the incentives scheme of the panel provider, which offered rewards in the form of points, cash, gift cards, or vouchers. Exclusion criteria included non-residency in Singapore or an inability to provide consent due to physical or cognitive impairment.

Measures

Outcome measures

Outcome measures were dichotomized as follows: Knowledge of lifespan was assessed by asking participants, "Do you know what lifespan is?" and requiring that they selected the correct definition as "the number of years a person is alive", were labelled as "Yes", while the three incorrect options— "the number of years spent as an adult", "the number of years in retirement", and "the distance between your two arms when you extend them", were labelled as "No". Similarly, knowledge of healthspan was assessed by asking, "Do you know what healthspan is?" The accurate definition "the number of years a person spends in good health" was labelled as "Yes", whereas the incorrect options — "the budget a government can allocate to healthcare", "the number of years a person

spends with chronic disease", and "the number of years a person lives" were labelled as "No".

After providing an introduction to HLM clinics — "A Healthy Longevity Medicine clinic offers a comprehensive assessment (2 h) of biological, physical, cognitive, and mental measures, which is followed by advice from a doctor and other healthcare professionals to optimise health via personalised lifestyle changes (e.g. diet, exercise, sleep), supplements, and medication, interest in them was assessed through a binary (yes/no) survey question evaluating participants' willingness to engage with or utilise the clinic's services.

Sociodemographic

Age was collected as self-reported chronological age and perceived age; both measured in years. Chronological age was defined as the participant's actual age, while perceived age captured the number in years answered to the question "how old do you feel?". Gender was categorised as female, male, or other based on participant self-identification. Ethnicity was grouped into Singapore's four officially recognised categories: Chinese, Indian, Malay, and others. Residency status was classified as citizen, permanent resident, or non-resident/foreigner. Work status was defined as full-time, part-time, or casual work, retired and working, retired, or unemployed. Educational attainment was categorised into six levels: postgraduate degree, undergraduate degree, diploma or certificate, secondary school or equivalent, primary school or equivalent, and no formal education. Religion was categorised as Buddhism, Christianity, Islam, Hinduism, Taoism, no religion, or other religions. Marital status was defined as married, single (never married), divorced, widowed, or separated. Family structure included two variables: whether participants had children (yes or no) and whether they had grandchildren (yes or no). Monthly household income was grouped into seven ranges, from "$500 or below" to "$10,001 or more", with an additional category for "refused to answer". Monthly individual income was classified into the same categories with the inclusion of a "no income" category. Housing type was categorised as Housing Development Board (HDB) 5-room or executive, HDB 4-room, HDB 3-room, HDB 1-room or 2-room, condominium or other apartment, and landed property or others. The Housing and Development Board (HDB) is Singapore's public housing authority, responsible for planning and developing estates. With over 80% of residents living in public housing under a tiered subsidy scheme, HDB flat size serves as a proxy for socioeconomic status (SES), as smaller (1–2 room) flats have income eligibility caps [20].

Health and lifestyle

Body mass index (BMI) was calculated using height in metres (m) and weight (kg). Chronic disease status was defined as the absence or presence of any chronic medical conditions. Medication use and supplement use were each classified as yes or no. Alcohol consumption was categorised as no alcohol consumption, 1 to 7 drinks per week, 8 to 14 drinks per week, or 15 or more drinks per week. Smoking status was classified as never smoked, used to smoke regularly, or currently smoking. Exercise frequency was measured in number of days per week, from 0 to 7. Enrolment in HealthierSG, a 2023 national initiative encouraging Singapore citizens to register with a family doctor for primary and preventive care, was also assessed, with responses categorised as "yes", "no", or "not qualified to enrol" [21, 22]. Completion of any annual health screening was recorded as "yes" or "no".

Data analysis

Quality check

A minimum completion threshold was established, requiring respondents to answer all questions in Section A and at least the first five questions of Section B. As these items constitute the essential knowledge-based metrics for lifespan and healthspan necessary for a clinically meaningful analysis, any responses failing to meet this threshold were excluded from the study to ensure the research objectives were accurately addressed.

Analyses

Three separate analyses were performed to determine the association between socio-demographic characteristics and: [1] knowledge of lifespan, [2] knowledge of healthspan, and [3] interest in engaging HLM clinics services. Crude and age-adjusted logistic regressions were employed to assess determinants of

knowledge regarding lifespan and healthspan, as well as interest in HLM clinics, which are presented as odds ratios (OR) with 95% confidence intervals (CI). Reference categories for categorical variables in the regression models were selected based on a combination of theoretical reasoning and sample size considerations, using the most common or standard group as the baseline for interpretation. The statistical significance level was set at $\alpha = 0.05$. All analyses were conducted using SPSS version 27.

Results

Sample characteristics

The HELO cohort consists of 3034 participants, of which 2003 were enrolled via door-to-door data collection and 1031 via online collection. The final sample size $n = 3034$ was determined after excluding $n = 289$ participants who failed to meet the established completion threshold, specifically by not answering the mandatory items in Section A and the first five questions of Section B.

Table 1 outlines the demographic and health profiles of the participants. The median age of the total cohort was 46 years [IQR, 34–59], while the median perceived age was 41 years [IQR, 32–56]. The majority were female (54.1%), Chinese (71.0%), and Singapore citizens (83.4%). Nearly half of the participants were highly educated (proportion with postgraduate degrees, 14.6%; and undergraduate degrees, 31.1%). The largest groups earned between SGD 5001–10,000 (26.9%) or above (26.6%) monthly, while 13.3% declined to disclose their income. Most participants were Singapore citizens (83.4%), with permanent residents comprising 10.1% and non-residents or foreigners comprising 6.4% of the sample. A majority were married (63.9%), followed by those who were single and never married (28.2%), divorced (4.0%), widowed (3.2%), and separated (0.7%). Additionally, 60.9% of participants reported having children. Most participants (77.6%) also reported no chronic diseases and not taking medications (67.6%), while 50.1% reported using supplements. Approximately half of the participants (47.3%) were enrolled in the HealthierSG initiative, while 53.9% had undergone annual health screenings. Lifestyle behaviours indicated that 69.1% reported they did not consume alcohol and that 80.5% had never smoked. A total of 19.1% of respondents reported no physical exercise. Among those who exercised, 13.7% did so once per week, 16.5% exercised twice per week, and 18.8% exercised three times per week. Characteristics of the cohort stratified according to the sampling methodology are given in Supplementary Table S1.

Knowledge about lifespan and healthspan and interest in attending Healthy Longevity Medicine clinics

Figure 1 illustrates the distribution of participants' understanding of the definitions for lifespan and healthspan, as well as their interest in the services offered at a HLM clinic. Most participants accurately identified the correct definition of lifespan (82.3%), while about half as many were able to identify the correct definition of healthspan (41.3%). Overall, 55.5% of the participants indicated interest in HLM clinics.

Demographic associations with knowledge regarding lifespan, healthspan, and interest in attending Healthy Longevity Medicine clinics

Table 2 presents unadjusted associations providing an overview of the crude relationships between demographic characteristics and participants' knowledge of lifespan and healthspan, and interest in HLM clinics. Lower chronological age (Fig. 2) and male gender were statistically significantly associated with better knowledge of lifespan and higher interest in attending a HLM clinic. Chinese participants had better knowledge of lifespan compared to other ethnicities. Christianity was consistently associated with better knowledge and more interest in HLM clinics compared to other religions.

Age-adjusted demographic associations with knowledge regarding lifespan, healthspan, and interest in attending Healthy Longevity Medicine clinics

To account for the potential confounding effect of age, Table 3 presents age-adjusted demographic characteristics and their association with knowledge of lifespan and healthspan and interest in HLM clinics. Having no grandchildren was statistically significantly associated with better knowledge of lifespan and stronger interest

Table 1 Characteristics of participants

	n	**Total (*N* = 3034)**
Age, year, median, IQR	3029	46, [34–59]
Perceived age, year, median, IQR	2999	41, [32–56]
Perceived age—Chronological age, year, IQR	2996	−1, [−5 to −1]
Gender		
Female	3031	1641 (54.1)
Male		1372 (45.2)
Other		18 (0.6)
Ethnicity		
Chinese	3032	2155 (71.0)
Indian		358 (11.8)
Malay		353 (11.6)
Others		166 (5.5)
Residency		
Citizen	3033	2531 (83.4)
Permanent Resident		307 (10.1)
Non-resident/Foreigner		195 (6.4)
Work		
Full-time	3033	1915 (63.1)
Part-time/Casual Worker		319 (10.5)
Retired and working		53 (1.7)
Retired		393 (13.0)
Unemployed		353 (11.6)
Education		
Postgraduate Degree	3033	443 (14.6)
Undergraduate Degree		945 (31.1)
Diploma/Certificate/ Professional Certificate		864 (28.5)
Secondary School or equivalent		596 (19.6)
Primary School or equivalent		153 (5.0)
No formal education		32 (1.1)
Religion		
Buddhism	3032	839 (27.7)
Christianity		719 (23.7)
Islam		457 (15.1)
Hinduism		230 (7.6)
Taoism		157 (5.2)
No religion		559 (18.4)
Other religion		71 (2.3)
Marital status		
Married	3034	1940 (63.9)
Single (never married)		857 (28.2)
Divorced		120 (4.0)
Widowed		97 (3.2)
Separated		20 (0.7)
Children, yes	3034	1847 (60.9)
Grandchildren, yes	3029	419 (13.8)

Table 1 (continued)

	n	Total (*N* = 3034)
Family members past 90 years		
No	2773	1826 (60.2)
Yes		873 (28.8)
Don't know		74 (2.4)
Monthly household income		
$500 or below	3025	103 (3.4)
$501–$1000		117 (3.9)
$1001–$2500		249 (8.2)
$2501–$5000		527 (17.4)
$5001–$10,000		817 (26.9)
$10,001 or more		807 (26.6)
Refuse to answer		405 (13.3)
Monthly individual income		
No income		518 (17.1)
$500 or below	3032	86 (2.8)
$501– $1000		179 (5.9)
$1001–$2500		381 (12.6)
$2501–$5000		782 (25.8)
$5001–$10,000		620 (20.4)
$10,001 or more		229 (7.5)
Refuse to answer		237 (7.8)
Housing		
HDB 1-room or 2-room	3029	121 (4.0)
HDB 3-room		612 (20.2)
HDB 4-room		1058 (34.9)
HDB 5-room or Executive		813 (26.8)
Condominium or other apartment		335 (11.0)
Landed/Others		90 (2.9)
Height, cm, median, IQR	3024	164 [158–171]
Weight, kg, median, IQR	3029	63 [55–74]
BMI, kg/m^2, median, IQR	3023	23.4 [20.9–26.6]
Chronic disease, no	3030	2355 (77.6)
Medications taken, no	3033	2052 (67.6)
Supplements use, yes	3031	1519 (50.1)
Alcohol consumption per week		
0	3033	2098 (69.1)
1–7 drinks		796 (26.2)
8–14 drinks		54 (1.8)
15 + drinks		37 (1.2)
Refuse to answer		48 (1.6)
Smoking		
Never smoked	3030	2442 (80.5)
Used to smoke regularly		312 (10.3)
Currently smoke		276 (9.1)

Table 1 (continued)

	n	Total (*N* = 3034)
Exercise		
0 days	3028	579 (19.1)
1 day		416 (13.7)
2 days		501 (16.5)
3 days		571 (18.8)
4 days		280 (9.2)
5 days		297 (9.8)
6 days		88 (2.9)
7 days		296 (9.8)
Health Insurance		
Government	3034	2051 (67.6)
Private		835 (27.52)
None		148 (4.88)
Enrolled in HealthierSG		
No	3033	1478 (48.7)
Yes		1435 (47.3)
Not qualified to enrol		120 (4.0)
Done annual health screening, yes	3032	1634 (53.9)

Notes: Data are presented as *n* (%) unless otherwise indicated

Abbreviations: *IQR* interquartile range, *HDB* Housing Development Board, *BMI* body mass index

in attending a HLM clinic, while those having family members aged 90 years or older had better knowledge of healthspan. Higher education was consistently associated with better knowledge of lifespan, healthspan, and interest in HLM clinics. Those with full-time employment had better knowledge of lifespan than those unemployed, as well as better knowledge of healthspan and interest in HLM clinics than those who were retired or unemployed. When compared to those earning less than $500 per month, a household income of $2501 and more was associated with better knowledge of lifespan and interest in HLM clinics, while those with income of more than $5001 had better knowledge of healthspan and interest in HLM clinics. Additionally, those residing in a condominium demonstrated better knowledge of lifespan and expressed more interest in HLM clinics.

Age-adjusted health associations with knowledge regarding lifespan, healthspan, and interest in attending Healthy Longevity Medicine clinics

Table 4 shows the associations between health characteristics with knowledge and interest in HLM clinics, adjusting for chronological age. A lower body mass index (BMI) was associated with better knowledge of lifespan and interest in HLM clinics. Additionally, taking supplements was associated with knowledge of lifespan, healthspan, and interest in HLM clinics. Those consuming 1–7 drinks of alcohol per week, compared to nil drinks, had better knowledge of lifespan and healthspan and interest in HLM clinics. Regular exercise was associated with better outcomes, with those exercising for 2 days or more per week reporting better scores in knowledge of healthspan and interest in HLM clinics. Having government health insurance and being enrolled in HealthierSG were both associated with better knowledge of lifespan and healthspan and interest in HLM clinics. Participants who underwent annual health screening and who paid out-of-pocket had higher odds of knowing the definition of healthspan and being interested in attending HLM clinics.

Discussion

The HELO survey revealed strong public knowledge of lifespan and less widespread understanding of

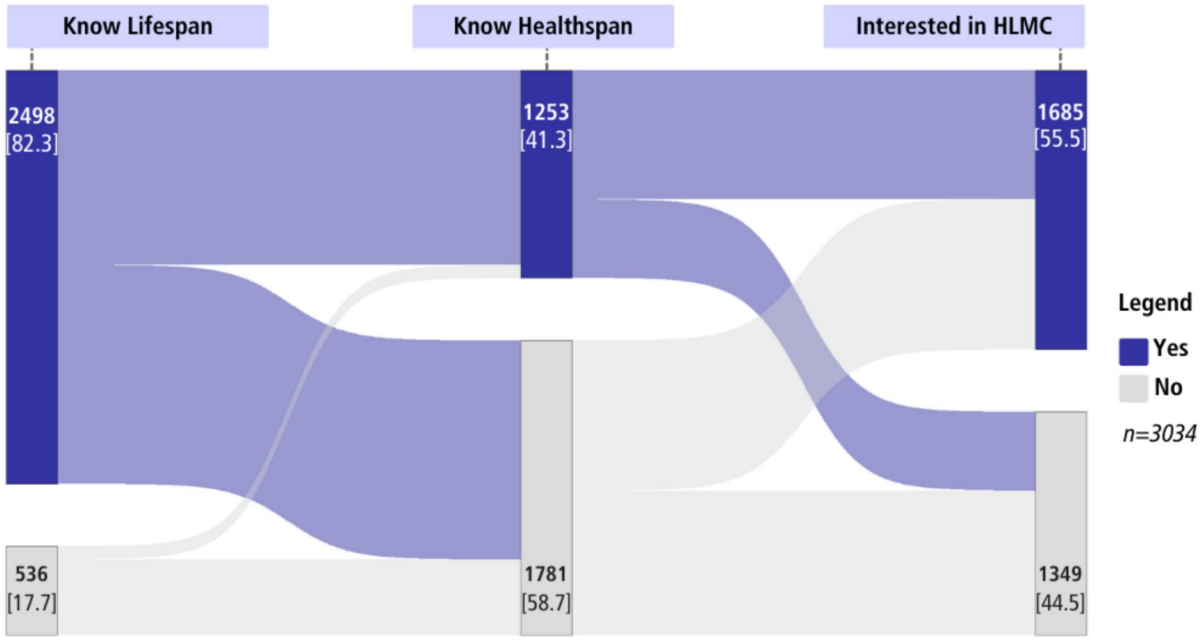

Fig. 1 Knowledge of lifespan and healthspan and interest in a Healthy Longevity Medicine clinic

Table 2 Association between demographic characteristics and knowledge of lifespan and healthspan and interest in attending Healthy Longevity Medicine clinics

	Knowledge of lifespan		**Knowledge of healthspan**		**Interested in HLM clinics**	
	Crude OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Crude OR [95% CI]	*P*
Chronological age, year	0.98 [0.97–0.98]	**< 0.001**	1.00 [0.99–1.00]	0.230	0.99 [0.98–0.99]	**< 0.001**
Gender, female, reference						
Male	1.28 [1.06–1.55]	**0.010**	1.13 [0.98–1.31]	0.090	1.20 [1.04–1.39]	**0.010**
Other	0.62 [0.22–1·75]	0.370	1.20 [0.47–3.07]	0.700	0.43 [0.16–1.16]	0.100
Indian	0.46 [0.36–0.60]	**< 0.001**	1.00 [0.80–1·25]	0.990	0.82 [0.65–1.02]	0.080
Malay	0.58 [0.44–0.76]	**< 0.001**	0.83 [0.66–1.04]	0.110	0.80 [0.64–1.01]	0.060
Others	0.63 [0.43–0.93]	**0.020**	0.91 [0.66–1·26]	0.580	1.30 [0.94–1.79]	0.120
Residency, citizen, reference						
Permanent resident	0.75 [0.56–1.01]	0.060	1.44 [1.13–1.82]	**0.003**	1.21 [0.95–1.54]	0.120
Non-resident	0.55 [0.39–0.76]	**< 0.001**	1.10 [0.82–1.48]	0.530	0.73 [0.54–0.98]	**0.030**
Religion, Buddhism, reference						
Christianity	1.41 [1.06–1.86]	**0.020**	1.23 [1.01–1.51]	**0.040**	1.74 [1.42–2.14]	**< 0.001**
Islam	0.68 [0.52–0.90]	**0.007**	0.96 [0.76–1.21]	0.750	1.03 [0.82–1.29]	0.830
Hinduism	0.57 [0.40–0.80]	**0.001**	1.03 [0.77–1.39]	0.830	0.81 [0.60–1.08]	0.150
Taoism	0.84 [0.55–1.28]	0.410	0.91 [0.64–1.29]	0.590	0.90 [0.64–1.27]	0.540
No religion	1.5 [1.10–2.03]	**0.010**	0.97 [0.78–1.20]	0.760	1.12 [0.90–1.39]	0.310
Other religion	0.63 [0.36–1.11]	0.110	0.85 [0.51–1.40]	0.520	0.99 [0.61–1.61]	0.970

[*] *p*-value refers to the comparison with the reference group

Abbreviations: *OR* odds ratio, *CI* confidence interval

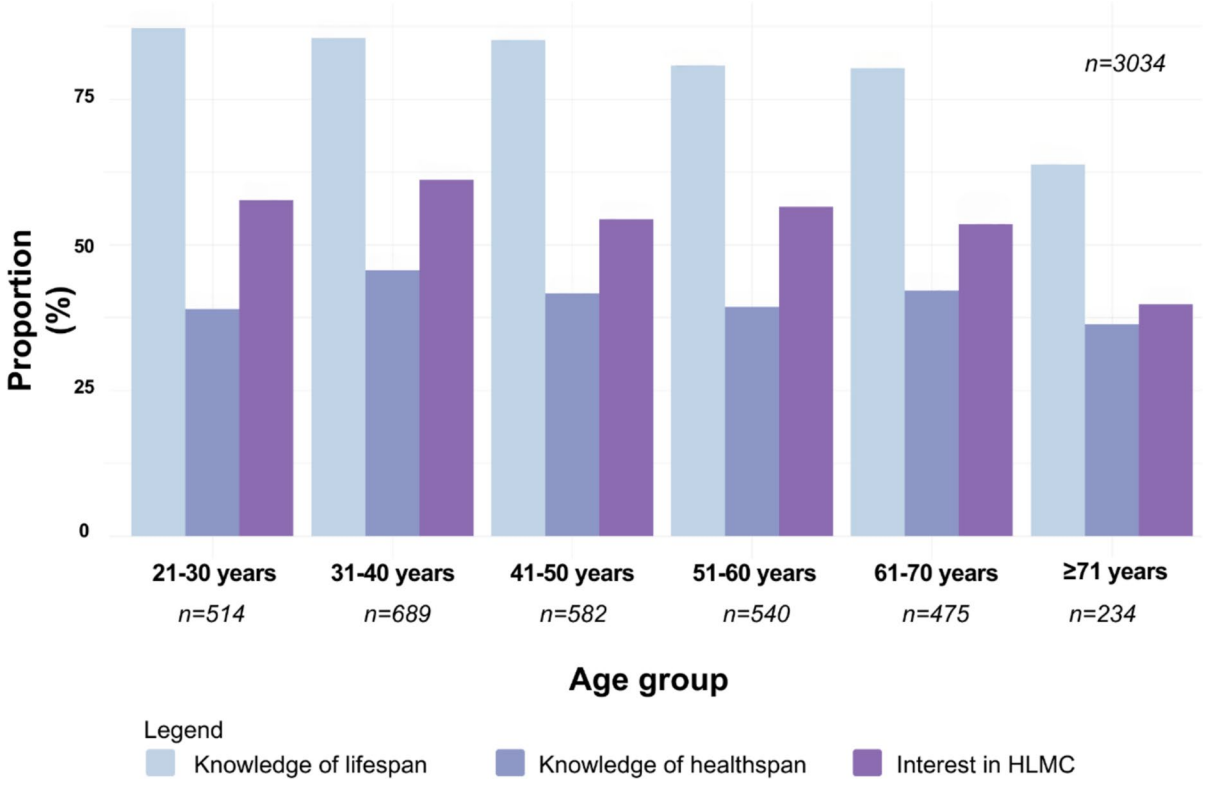

Fig. 2 Proportion of accurate answers regarding lifespan and healthspan definitions and interest in attending Healthy Longevity Medicine clinics, stratified by age groups

healthspan in the general population of Singapore. More than half of the population expressed interest in HLM clinics. Younger chronological age, male gender, Chinese ethnicity, Christianity, higher education, full-time employment, and higher income were positively associated with knowledge and interest in HLM clinics. Having no grandchildren was linked to better knowledge of lifespan and interest in HLM clinics, while family members living past 90 years were associated with better healthspan knowledge. Health determinants included lower BMI, taking supplements, moderate (vs. no) alcoholic intake, regular exercise, having government health insurance, enrolment in HealthierSG, and completing annual (self-paid) health screenings, all of which were associated with better knowledge and interest in HLM clinics. The factors with the largest effect sizes for both knowledge of lifespan and healthspan, as well as interest in HLM clinics, included having government health insurance and basic education. Additionally, an income above SGD 2,501 and paying out-of-pocket for health screenings were associated with greater interest in visiting HLM clinics.

The observed disparity between public knowledge of lifespan and healthspan highlights a weaker understanding of the concept of healthy longevity. The United Nations Decade of Healthy Ageing seeks to address the needs of an ageing population by integrating social, biological, economic, and environmental determinants of healthy ageing across the lifespan, and by promoting interventions to extend healthspan [23]. The limited understanding of healthy longevity is echoed by the Hevolution Foundation survey, which found only 30% of 4000 citizens self-reported their familiarity with the concept [24]. Defining lifespan and healthspan requires consensus and standardisation to effectively disseminate these concepts to the public and develop targeted strategies for healthy ageing policies within global healthcare systems [12]. Despite this, more than half of the participants expressed interest in HLM clinics, suggesting a recognised need and willingness to improve

Table 3 Association between demographic characteristics and knowledge of lifespan and healthspan and interest in attending Healthy Longevity Medicine clinics, adjusted for chronological age

	Knowledge of lifespan				Knowledge of healthspan				Interested in HLM clinics			
	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*
Marital status, married, reference												
Single never married	1.33 [1.06–1.66]	**0.013**	1.02 [0.80–1.30]	0.866	0.89 [0.76–1.05]	0.180	0.84 [0.71–1.00]	0.059	1.06 [0.90–1.25]	0.460	0.91 [0.77–1·09]	0.318
Divorced	0.80 [0.51–1.26]	0.340	0.92 [0.58–1.46]	0.736	0.91 [0.62–1.32]	0.610	0.91 [0.62–1·32]	0.616	1.02 [0.70–1.48]	0.910	1.07 [0.74–1.56]	0.719
Widowed	0.55 [0.35–0.86]	**0.009**	0.84 [0.52–1.34]	0.458	0.80 [0.53–1.22]	0.310	0.88 [0.57–1.36]	0.553	0.67 [0.45–1.01]	0.060	0.86 [0.56–1.31]	0.474
Separated	0.52 [0.20–1.36]	0.180	0.52 [0.20–1.38]	0.192	0.73 [0.29–1.84]	0.510	0.74 [0.29–1.85]	0.515	1.89 [0.72–4.93]	0.200	1.92 [0.73–5.03]	0.184
Children, yes	0.70 [0.57–0.85]	**< 0.001**	0.91 [0.74–1.13]	0.413	1.07 [0.92–1.23]	0.397	1.13 [0·96–1·33]	0.136	0.91 [0.79–1.05]	0.209	1.06 [0.90–1.25]	0.475
Grandchildren, yes	0·43 [0.34–0.54]	**< 0.001**	0.63 [0.47–0.83]	**0.001**	0.86 [0.70–1.06]	0.159	0.88 [0.69–1.13]	0.326	0.64 [0.52–0.80]	**< 0.001**	0.78 [0.61–0.99]	**0.043**
Family members past 90 years, yes, reference												
No	0.92 [0.74–1.14]	0.429	0.90 [0.72–1.12]	0.335	0.73 [0.62–0.86]	**< 0.001**	0.73 [0.62–0.86]	**< 0.001**	0.87 [0.74–1.03]	0.105	0.87 [0.74–1.03]	0.098
Don't know	1.15 [0.59–2.24]	0.680	0.97 [1.50–1.90]	0.933	0.54 [0.33–0.89]	**0.017**	0·52 [0.32–0.87]	**0.012**	0.89 [0.55–1.44]	0.641	0.82 [0.51–1.33]	0.416
Education, Postgraduate Degree, reference												
Undergraduate Degree	1.45 [1.00–2.10]	**0.050**	1.45 [1.00–2.10]	0.052	0.92 [0.74–1.16]	0.481	0.94 [0.75–1.18]	0.577	1.08 [0.85–1.36]	0.550	1.08 [0.85–1.38]	0.517
Diploma/ Certificate/Professional Certificate	0.68 [0.49–0.97]	**0.030**	0.69 [0.49–0.97]	**0.034**	0.76 [0.60–0.95]	**0.017**	0.75 [0.60–0.95]	**0.016**	0.55 [0.44–0.70]	**< 0.001**	0.56 [0.44–0.71]	**< 0.001**
Secondary School or equivalent	0.30 [0.21–0.42]	**< 0.001**	0.30 [0.21–0.43]	**< 0.001**	0.59 [0.46–0.75]	**< 0.001**	0.55 [0.42–0.71]	**< 0.001**	0.35 [0.27–0.46]	**< 0.001**	0.35 [0.27–0.45]	**< 0.001**

Table 3 (continued)

	Knowledge of lifespan				Knowledge of healthspan				Interested in HLM clinics			
	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*
Primary School or equivalent	0.16 [0.10–0.24]	**< 0.001**	0.16 [0.10–0.25]	**< 0.001**	0.49 [0.33–0.72]	**< 0.001**	0.43 [0.28–0.64]	**< 0.001**	0.40 [0.27–0.58]	**< 0.001**	0.38 [0.26–0.56]	**< 0.001**
No formal education	0.09 [0.04–0.19]	**< 0.001**	0.09 [0.04–0.19]	**< 0.001**	0.20 [0.08–0.54]	**0.001**	0.18 [0.07–0.48]	**< 0.001**	0.12 [0.05–0.30]	**< 0.001**	0.12 [0.05–0.29]	**< 0.001**
Work status, full-time, reference												
Part-time/ Casual Worker	0.98 [0.70–1.35]	0.880	1.08 [0.77–1.51]	0.640	0.80 [0.63–1.02]	0.080	0.82 [0.64–1.05]	0.119	0.88 [0.70–1.12]	0.310	0.91 [0.71–1.16]	0.432
Retired and working	0.56 [0.29–1.06]	0.070	0.89 [0.46–1.72]	0.730	0.93 [0.54–1.62]	0.800	1.10 [0.62–1.93]	0.753	1.13 [0.64–1.98]	0.680	1.34 [0.75–2.38]	0.322
Retired	0.55 [0.43–0.72]	**< 0.001**	0.99 [0.72–1.36]	0.960	1.11 [0.89–1.38]	0.350	1.34 [1.03–1.74]	**0.029**	0.55 [0.44–0.69]	**< 0.001**	0.67 [0.52–0.87]	**0.003**
Unemployed	0.61 [0.46–0.80]	**< 0.001**	0.61 [0.46–0.81]	**< 0.001**	0.53 [0.42–0.68]	**< 0.001**	0.53 [0.41–0.68]	**< 0.001**	0.55 [0.44–0.70]	**< 0.001**	0.55 [0.44–0.69]	**< 0.001**
Monthly household income, $500 or below, reference												
$501–$1000	1.17 [0.68–2.04]	0.570	1.12 [0.65–1.96]	0.680	1.30 [0.75–2.26]	0.340	1.30 [0.75–2.26]	0.345	1.41 [0.81–2.45]	0.220	1.39 [0.80–2.41]	0.245
$1001–$2,500	1.50 [0.92–2.43]	0.100	1.44 [0.89–2.35]	0.138	1.08 [0.67–1.75]	0.750	1.08 [0.66–1.75]	0.754	1.46 [0.90–2.36]	0.130	1.44 [0.89–2.32]	0.142
$2501–$5000	2.88 [1.82–4.55]	**< 0.001**	2.57 [1.62–4.09]	**< 0.001**	0.98 [0.63–1.53]	0.940	0.98 [0.63–1.53]	0.926	2.12 [1.36–3.30]	**< 0.001**	2.00 [1.28–3.13]	**0.002**
$5001–$10,000	4.47 [2.85–7.02]	**< 0.001**	3.83 [2.42–6.08]	**< 0.001**	1.73 [1.13–2.66]	**0.010**	1.73 [1.12–2.67]	**0.014**	3.04 [1.97–4.69]	**< 0.001**	2.86 [1.84–4.44]	**< 0.001**
$10,001 or more	6.13 [3.85–9.76]	**< 0.001**	5.24 [3.27–8.42]	**< 0.001**	1.56 [1.02–2.41]	**0.040**	1.57 [1.01–2.42]	**0.044**	4.42 [2.85–6.84]	**< 0.001**	4.17 [2.69–6.50]	**< 0.001**
Refuse to answer	1.48 [0.94–2.33]	0.090	1.41 [0.89–2.22]	0.143	1.23 [0.78–1.94]	0.370	1.22 [0.78–1.93]	0.389	1.67 [1.06–2.64]	**0.030**	1.62 [1.03–2.56]	**0.038**
Monthly individual income, $500 or below, reference												
$501–$1000	1.17 [0.62–2.23]	0.630	1.30 [0.68–2.48]	0.432	1.43 [0.83–2.45]	0.200	1.44 [0·84–2.47]	0.191	0.97 [0.58–1.62]	0.900	1.00 [0.60–1.68]	0.991
$1001–$2500	0.84 [0.48–1.49]	0.560	0.96 [0.54–1.70]	0.875	1.47 [0.89–2.41]	0.130	1.49 [0.90–2.44]	0.118	1.06 [0.67–1.70]	0.790	1.11 [0.69–1.77]	0.676

Table 3 (continued)

	Knowledge of lifespan				Knowledge of healthspan				Interested in HLM clinics			
	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*
$2501–$5000	1.46 [0.84–2.54]	0.180	1.43 [0.82–2.51]	0.207	1.51 [0.94–2.43]	0.090	1.51 [0.94–2.43]	0.087	1.60 [1.02–2.49]	**0.040**	1.59 [1.02–2.49]	**0.042**
$5001–$10,000	2.67 [1.48–4.80]	**0.001**	2.71 [1.50–4.91]	**< 0.001**	1.60 [0.99–2.58]	**0.050**	1.59 [0.99–2.57]	0.056	1.96 [1.24–3.09]	**0.004**	1.98 [1.26–3.11]	**0.003**
$10,001 or more	2.62 [1.32–5.21]	**0.006**	2.74 [1.38–5.47]	**0.004**	1.95 [1.16–3.28]	**0.010**	1.97 [1.17–3.32]	**0.011**	2.43 [1.46–4.04]	**< 0.001**	2.53 [1.52–4.21]	**< 0.001**
No income	0.79 [0.45–1.38]	0.410	0.98 [0.56–1.73]	0.951	1.10 [0·68–1.79]	0.690	1.11 [0.68–1.82]	0.670	0.79 [0.50–1.24]	0.300	0.85 [0.53–1.34]	0.480
Refuse to answer	0.67 [0.37–1.21]	0.190	0.72 [0.40–1.31]	0.281	1.54 [0.92–2.59]	0.100	1.53 [0.91–2.57]	0.109	0.86 [0.53–1.41]	0.560	0.87 [0.53–1.44]	0.595
Housing, HDB 1-room or 2-room, reference												
HDB 3-room	0.93 [0.59–1.49]	0.770	0.93 [0.59–1.49]	0.773	0.94 [0.63–1.40]	0.760	0.95 [0.64–1.41]	0.70 [0.47–1.03]		0.070	0.72 [0.48–1.07]	0.105
HDB 4-room	1.34 [0.85–2.11]	0.210	1.34 [0.85–2.11]	0.211	0.89 [0.62–1.31]	0.560	0.89 [0.61–1.30]	0.75 [0.51–1.10]		0.140	0.74 [0.51–1.09]	0.127
HDB 5-room or Executive	1.66 [1.04–2.65]	**0.030**	1.66 [1.04–2.65]	**0·035**	1.02 [0.69–1.50]	0.910	1.03 [0.70–1.52]	0.97 [0.66–1.44]		0.900	1.00 [0.68–1.48]	0.985
Condominium or other apartment	2.00 [1.17–3.43]	**0.010**	2.00 [1.17–3.43]	**0.011**	1.00 [0.65–1.52]	0.990	1.00 [0.66–1.52]	1.68 [1.09–2.58]		**0.020**	1.70 [1.10–2.62]	**0.016**
Landed/ Others	1.44 [0.71–2.89]	0.310	1.44 [0.71–2.89]	0.311	1.37 [0.79–2.38]	0.260	1.38 [0.80–2.40]	1.11 [0.63–1.93]		0.720	1.14 [0.65–2.00]	0.639

*p-value refers to the comparison with the reference group

Abbreviations: *OR* odds ratio, *CI* confidence interval, *HDB* Housing Development Board

Table 4 Association between health characteristics and knowledge of lifespan and healthspan and interest in attending Healthy Longevity Medicine clinics, adjusted for chronological age

	Knowledge of lifespan				**Knowledge of healthspan**				**Interested in HLM clinics**			
	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*	Crude OR [95% CI]	*P*	Adjusted OR [95% CI]	*P*
Perceived age—chronological age, year	0.99 [0.99–1.00]	0.196	0.99 [0.98–1.00]	0.085	0.99 [0.98–0.99]	**0.015**	0.99 [0.97–0.99]	**0.005**	0.99 [0.99–1.00]	0.384	0.99 [0.99–1.00]	0.209
BMI, kg/m^2	0.96 [0.94–0.97]	**< 0.001**	0.96 [0.94–0.97]	**< 0.001**	0.98 [0.96–0.99]	**0.001**	0.99 [0.99–1.00]	0.237	0.98 [0.96–0.99]	**0.001**	0.99 [0.98–0.99]	**0.002**
Chronic disease, no	1.30 [1.05–1.62]	**0.016**	0.91 [0.72–1.16]	0.441	1.06 [0.89–1.26]	0.510	1.01 [0.84–1.23]	0.902	1.18 [1.00–1.40]	0.060	1.00 [0.83–1.21]	0.990
Medication, no	1.46 [1.20–1.77]	**< 0.001**	1.05 [0.85–1.31]	0.636	1.05 [0.90–1.22]	0.570	1.01 [0.85–1.20]	0.911	1.09 [0.93–1.27]	0.270	0.92 [0.77–1.08]	0.305
Supplements use, yes	1.44 [1.19–1.74]	**< 0.001**	1.55 [1.28–1.88]	**< 0.001**	1.38 [1.20–1.60]	**< 0.001**	1.40 [1.21–1.62]	**< 0.001**	1.68 [1.45–1.94]	**< 0.001**	1.75 [1.51–2.03]	**< 0.001**
Alcohol consumption, per week, 0 drinks, reference												
1–7 drinks	2.20 [1.71–2.83]	**< 0.001**	1.78 [1.50–2.11]	**< 0.001**	1.31 [1.11–1.54]	**0.001**	1.30 [1.10–1.53]	**0.002**	1.86 [1.57–2.21]	**< 0.001**	1.78 [1.50–2.12]	**< 0.001**
8–14 drinks	0.80 [0.42–1.50]	0.480	1.31 [0.76–2.28]	0.328	0.96 [0.55–1.68]	0.890	0.96 [0.55–1.67]	0·884	1.35 [0.78–2.34]	0.280	1.32 [0.76–2.28]	0.328
15 + drinks	0.79 [0.37–1.68]	0.530	0.79 [0.41–1.52]	0.479	0.73 [0.36–1.45]	0.370	0.73 [0.36–1.46]	0.369	0.79 [0.41–1.51]	0.480	0.79 [0.41–1.52]	0.479
Refuse to answer	1.09 [0.53–2.28]	0.810	0.45 [0.25–0.83]	0.011	0.76 [0.41–1.39]	0.370	0.76 [0.41–1.38]	0.363	0.46 [0.25–0.85]	**0.010**	0.45 [0.25–0.83]	**0.011**
Smoking, never smoked, reference												
Used to smoke regularly	1.02 [0.74–1.39]	0.920	0.97 [0.71–1.32]	0.835	1.02 [0.80–1.30]	0.860	1.02 [0.80–1.29]	0.894	1.0 [0.83–1.34]	0.660	1.03 [0.81–1.31]	0.785
Currently smoke	0.92 [0.67–1.26]	0.590	0.86 [0.63–1.19]	0.369	0.89 [0.69–1.15]	0.390	0.89 [0.69–1.15]	0.366	0.87 [0.68–1.11]	0.260	0.85 [0.66–1.09]	0.193
Exercise, per week, 0 days, reference												
1 day	1.22 [0.88–1.68]	0.240	1.14 [0.82–1.58]	0.428	1.20 [0.92–1.56]	0.180	1.19 [0.91–1.55]	0.201	1.47 [1.14–1.90]	**0.002**	1.43 [1.11–1.85]	**0.006**
2 days	1.62 [1.17–2.24]	**0.003**	1.45 [1.05–2.02]	**0.025**	1.60 [1.25–2.05]	**< 0.001**	1.58 [1.23–2.03]	**< 0.001**	1.54 [1.21–1.96]	**< 0.001**	1.46 [1.15–1.87]	**0.002**
3 days	1.15 [0.86–1.54]	0.350	1.10 [0.82–1.48]	0.540	1.45 [1.14–1.84]	**0.002**	1.44 [1.14–1.84]	**0.003**	1.59 [1.26–2.01]	**< 0.001**	1.55 [1.23–1.96]	**< 0.001**

Table 4 (continued)

	Knowledge of lifespan				Knowledge of healthspan				Interested in HLM clinics			
4 days	1.55 [1.05–2.29]	**0.030**	1.51 [1.01–2.24]	**0.043**	1.70 [1.27–2.27]	**< 0.001**	1.67 [1.25–2.24]	**< 0.001**	1.46 [1.10–1.95]	**0.009**	1.41 [1.06–1.89]	**0.019**
5 days	1.41 [0.97–2.05]	0.070	1.45 [0.99–2·11]	0.053	1.85 [1.39–2·46]	**< 0.001**	1.85 [1.39–2·47]	**< 0.001**	1.67 [1.25–2.21]	**< 0.001**	1.69 [1.27–2.25]	**< 0.001**
6 days	1.26 [0.70–2.27]	0.450	1.42 [0.77–2.61]	0.262	1.93 [1.23–3.03]	**0.005**	1.89 [1.20–2.98]	**0.006**	1.61 [1.02–2·53]	**0.040**	1.70 [1.07–2.69]	**0.024**
7 days	0.90 [0.64–1·27]	0.550	1.02 [0.72–1.44]	0.910	1.58 [1.18–2.10]	**0.002**	1.60 [1.20–2.14]	**0.001**	1.26 [0.95–1.66]	0.110	1.34 [1.01–1.78]	**0.042**
Health Insurance, Government, reference												
Private	0.76 [0.62–0.94]	**0.010**	0.70 [0.56–0.87]	**0.001**	0.89 [0.76–1.05]	0.170	0.88 [0.74–1.03]	0.117	1.00 [0.85–1.18]	0.990	0.97 [0.82–1.14]	0.676
None	0.23 [0.16–0.32]	**< 0.001**	0.21 [0.15–0.30]	**< 0.001**	0.39 [0.27–0.58]	**< 0.001**	0.39 [0.26–0.58]	**< 0.001**	0.55 [0.39–0.76]	**< 0.001**	0.53 [0.38–0.74]	**< 0.001**
Enrolled in HealthierSG, yes, reference												
No	0.84 [0.70–1.02]	0.078	0.67 [0.55–0.82]	**< 0.001**	0.73 [0.63–0.85]	**< 0.001**	0.71 [0.60–0.82]	**< 0.001**	0.70 [0.60–0.81]	**< 0.001**	0.60 [0.52–0.70]	**< 0.001**
Not qualified to enrol	1.12 [0.67–1.89]	0.667	0.71 [0.42–1.22]	0.213	1.42 [0.98–2.06]	0.066	1.32 [0.90–1.93]	0.160	0.68 [0.47–0.99]	**0.045**	0.52 [0.35–0.76]	**< 0.001**
Done annual health screening, yes	0.93 [0.77–1.13]	0.463	1.09 [0.90–1.32]	0.383	1.32 [1.14–1.53]	**< 0.001**	1.37 [1.18–1.59]	**< 0.001**	1.48 [1.28–1.71]	**< 0.001**	1.64 [1.41–1.90]	**< 0.001**
Paid out of pocket for annual health screening, yes	1.20 [0.93–1.54]	0.160	1.17 [0.91–1.52]	0.221	1.23 [1.01–1.50]	**0.040**	1.22 [1.00–1.49]	**0.044**	1.44 [1.18–1.76]	**< 0.001**	3.42 [1.16–1.74]	**< 0.001**

* *p*-value refers to the comparison with the reference group

Abbreviations: *OR* odds ratio, *CI* confidence interval, *BMI* body mass index

their healthspan. This enthusiasm reflects a growing demand for personalised and preventative healthcare solutions, particularly in Singapore, with the rising prevalence of ageing-related diseases and an increasing older-age population which have prompted national initiatives such as HealthierSG [22, 25]. The present finding aligns with insights from a previous focus group study, where Singaporean residents expressed optimism for HLM's potential in extending healthspan, raised concerns about the challenges of adopting necessary lifestyle changes, and discussed the importance of perceived autonomy over their way of living [16].

Interestingly, this study also observed that male participants and those with moderate alcohol consumption exhibited higher knowledge of lifespan and healthspan, as well as greater interest in HLM clinics. While this contrasts with prior literature in Singapore [26, 27] suggesting higher health literacy among women, several contextual factors may explain these findings. In Singapore, men consume alcohol more regularly than women but are twice as likely to meet the minimum exercise recommendations and show higher rates of help-seeking behaviour which are attributed to different intrinsic motivations [14, 28]. Men may have greater exposure to workplace health programmes or social networks promoting health-seeking behaviours, and moderate alcohol consumption may reflect higher socioeconomic status [29]. Nonetheless, current evidence from large-scale systematic reviews and meta-analyses suggests that low-volume alcohol consumption offers no consistent mortality benefit over lifetime abstention, warranting cautious interpretation [30]. These observations highlight the importance of considering cultural, behavioural, and social factors when designing public education campaigns for HLM.

Education

The findings carry several implications for public health and policy. The disparity between knowledge of lifespan and healthspan underscores the need for targeted educational campaigns to enhance awareness and promote evidence-based preventive health, facilitating the clinical translation of geroscience into Precision Geromedicine through HLM clinics. Enhancing health literacy on healthspan, including awareness of the healthspan-lifespan gap and misconceptions, is crucial for shifting the focus from lifespan extension to the number of healthy years in life. Effective health interventions should be designed and communicated with a clear understanding of population needs, particularly among disengaged groups at higher risk for chronic diseases while paying attention to structural factors such as access, affordability, and health system constraints, along with cultural beliefs, gender norms, and family influences.

Establishing Healthy Longevity Medicine

The high levels of knowledge and interest in HLM clinics observed in this study may be attributed to Singapore's proactive approach to geroscience and preventive health, including the establishment of a healthy longevity research clinic [31]. The HealthierSG initiative, launched in 2023, is a key driver in promoting preventive health by integrating general practitioners, community partners, and public hospitals to encourage early screening and lifestyle interventions [6, 22]. Complementing this, the NUS Academy for Healthy Longevity plays a pivotal role in education and capacity building, offering standardised training programmes to equip healthcare professionals with expertise in Precision Geromedicine [32]. Through targeted education and public health initiatives, Singapore is actively bridging the gap between geroscience research and clinical application, fostering a healthcare ecosystem that prioritises healthspan extension and evidence-based preventive care.

Study strength and limitations

To the authors' knowledge, the HELO survey is the first large-scale initiative to investigate public knowledge and interest in HLM, addressing a critical gap in the literature. While several predictors of knowledge and interest in Healthy Longevity Medicine showed statistically significant associations, some effect sizes were modest. Although these effect sizes may appear small at the individual level, slight increases in knowledge or engagement, when applied across large segments of the population, can translate into substantial public health benefits. Nevertheless, caution is warranted when interpreting these findings and practical implementation of interventions should balance effect size with feasibility, cost, and potential scalability.

A key limitation of this study is its reliance on self-reported data, which may be subject to recall bias and social desirability bias, as participants may not remember certain health-related information well or could have overestimated their interest in attending HLM clinics to align with perceived societal expectations. This could lead to inflated estimates of interest, potentially overestimating the population's openness to HLM clinics. Secondly, the study assessed public knowledge of lifespan and healthspan, but variations in individual interpretations of these terms could have influenced responses. As the correct definition needed to be selected between four options, we cannot exclude that some participants responded accurately by chance or by deducing which one was the most probable answer without having prior knowledge about the term itself. Given the possibility of guessing correct answers in multiple-choice knowledge items, uncertainty in the estimates may be underestimated. Further, without a universally accepted and standardised definition of healthspan [12], participants may have conceptualised the term differently, leading to inconsistencies in self-reported knowledge. Standardising definitions across various cultural contexts can help assess conceptual understanding and accuracy of future research on public awareness of lifespan and healthspan. Furthermore, the findings may not be fully generalisable to other populations with different healthcare systems, cultural attitudes, and levels of exposure to geroscience, necessitating initiatives such as the ongoing global rollout of the HELO survey involving a consortium of over multiple countries [13]. The HELO global consortium aims to understand population-level knowledge gaps, which in turn helps promote equitable access to healthy longevity services and supports cross-cultural adaptation of interventions, in alignment with the National Academy of Medicine's Global Roadmap for Healthy Longevity [33].

As the study's cross-sectional design captures associations at a single point in time, it did not make it possible to capture longitudinal or causal relationships. Longitudinal studies are needed to assess changes in awareness and engagement over time and to evaluate whether targeted interventions lead to sustained improvements in knowledge and interest in HLM clinics.

In conclusion, the HELO survey in Singapore highlights the urgent need for improved public education about key concepts of healthy longevity, such as healthspan, and equitable access to HLM as a proactive response to the challenges of ageing populations. HLM offers a key opportunity to optimise healthspan through education, health literacy, and the establishment of HLM clinics. This approach could alleviate the strain on healthcare systems, advancing more sustainable and proactive care models worldwide. Further efforts are needed to refine strategies, build consensus on concepts such as healthspan, and ensure the effective implementation of this field of medicine to meet the complex needs of an ageing population.

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Declarations

Ethics and consent to participate Ethics approval for the study was obtained from the Institutional Review Board at the National University of Singapore (NUS-IRB-2023-672). Written or electronic informed consent was obtained from all participants prior to data collection.

Competing interests The authors declare no competing interests.

References

1. Scott A, Ellison M, Sinclair D. The economic value of targeting aging. Nat Aging. 2021;1:1–8.
2. Speech by Mr Ong Ye Kung. Minister for Health, at the Motion debate on supporting healthcare: 10 May 2023 [press release]. Singapore. M 2023;10:2023.
3. Institute for Health Metrics and Evaluation (IHME). Global Burden of Diseases 2019 results. Global Health Data Exchange. Seattle, Washington 2020.
4. Department of Statistics Singapore. Population and population structure 2023 [Available from: https://www.singstat.gov.sg/find-data/search-by-theme/population/population-and-population-structure/latest-data.
5. Fulop T, Larbi A, Khalil A, Cohen AA, Witkowski JM. Are we ill because we age? Front Physiol. 2019;10.
6. Amalaraj JJP, Island L, Ong JYY, Wang L, Valderas JHM, Dunn M, et al. Towards precision geromedicine in Singapore. Geroscience. 2025. https://doi.org/10.1007/s11357-025-01686-7.
7. Kroemer G, Maier AB, Cuervo AM, Gladyshev VN, Ferrucci L, Gorbunova V, et al. From geroscience to precision geromedicine: understanding and managing aging. Cell. 2025;188(8):2043–62.
8. Donner Y, Fortney K, Calimport SRG, Pfleger K, Shah M, Betts-LaCroix J. Great desire for extended life and health amongst the American public. frontiers in genetics. 2016;6.
9. McKinsey Health Insititute. Age is just a number: how older adults view healthy aging. 2023.
10. Crimmins EM. Lifespan and healthspan: past, present, and promise. Gerontologist. 2015;55(6):901–11.
11. Kaeberlein M. How healthy is the healthspan concept? GeroScience. 2018;40(4):361–4.
12. Masfiah S, Kurnialandi A, Meij JJ, Maier AB. Definitions of healthspan: a systematic review. Ageing Res Rev. 2025;111.
13. Wang B, Szücs A, Sandalova E, Horberg EJ, O'Keefe PA, Island L, et al. Awareness, knowledge, and motivations about lifespan, healthspan, and Healthy Longevity Medicine in the general population: the HEalthy LOngevity (HELO) conceptual framework. Geroscience. 2025;47(3):4567–76.
14. Khow YZ, Lim TLY, Ng JSP, Wu J, Tan CS, Chia KS, et al. Behavioral impact of national health campaigns on healthy lifestyle practices among young adults in Singapore: a cross-sectional study. BMC Public Health. 2021;21(1).
15. Teo KW, Low LL, Gan WH, Low LSG, Lee CE. Expanding the role of community hospitals to promote population health in Singapore. The Lancet Regional Health – Western Pacific. 2025. https://doi.org/10.1016/j.lanwpc.2025.101477.
16. Wang B, Szücs A, Sandalova E, Horberg EJ, O'Keefe PA, Island L, et al. Public views towards lifespan, healthspan, and Healthy Longevity Medicine in Singapore: a qualitative study from the HEalthy LOngevity (HELO) initiatives. The Journals of Gerontology Series A (Submitted). 2024.
17. Walde P, Völlm BA. The TRAPD approach as a method for questionnaire translation. Front Psychiatry. 2023;14.
18. Urban Redevelopment Authority Singapore. Regional Highlights Singapore2024 [Available from: https://www.ura.gov.sg/Corporate/Planning/Master-Plan/Master-Plan-2019/Regional-Highlights.
19. Salmon CT, Nichols JS. The next-birthday method of respondent selection. Public Opin Q. 1983;47(2):270–6.
20. Lim DYZ, Wong TH, Feng M, Ong MEH, Ho AFW. Leveraging open data to reconstruct the Singapore Housing Index and other building-level markers of socioeconomic status for health services research. Int J Equity Health. 2021;20:1–9.
21. Milton K, Bull FC, Bauman A. Reliability and validity testing of a single-item physical activity measure. Br J Sports Med. 2011;45(3):203–8.
22. Ministry of Health Singapore. White paper on Healthier SG. Singapore 2022. p. 39.
23. United Nations. United Nations decade of healthy ageing: plan of action 2021–2030. New York: United Nations; 2021.
24. Hevolution. The global healthspan report. Hevolution; 2024.
25. The Lancet Regional Health – Western P. Healthier SG: for a healthier Singapore and beyond. The Lancet Regional Health – Western Pacific. 2023;37.
26. Suppiah SD, Malhotra R, Tan YW, Jessup RL, Chew LST, Tang W-E, et al. Prevalence of health literacy and its correlates from a national survey of older adults. Res Social Adm Pharm. 2023;19(6):906–12.
27. Chng NW, Kwek GJ, Cheong KY, Syed Mahmud SMB, Sheri VL, Wong DS, et al. Health literacy survey in health science students versus population-based sample of residents in Singapore. Glob Health Promot. 2025:17579759251337767.
28. Goh CMJ, Asharani PV, Abdin E, Shahwan S, Zhang Y, Sambasivam R, et al. Gender differences in alcohol use: a nationwide study in a multiethnic population. Int J Ment Heal Addict. 2024;22(3):1161–75.
29. Seaton CL, Bottorff JL, Caperchione CM, Johnson ST, Oliffe JL. The association between men's heath behaviors and interest in workplace health promotion. Workplace Health Saf. 2020;68(5):226–35.
30. Stockwell T, Zhao J, Clay J, Levesque C, Sanger N, Sherk A, et al. Why do only some cohort studies find health benefits from low-volume alcohol use? A systematic review and meta-analysis of study characteristics that may bias mortality risk estimates. J Stud Alcohol Drugs. 2024;85(4):441–52.

31. Bonnes SLR, Strauss T, Palmer AK, Hurt RT, Island L, Goshen A, et al. Establishing healthy longevity clinics in publicly funded hospitals. Geroscience. 2024. https://doi.org/10.1007/s11357-024-01132-0.
32. National University of Singapore. NUS Academy for Healthy Longevity, Singapore: National University of Singapore; 2024 [Available from: https://longevityacademy.sg/.
33. Fried LP, Wong JEL, Dzau V. A global roadmap to seize the opportunities of healthy longevity. Nat Aging. 2022;2(12):1080–3.