



OPEN Sociodemographic and clinical determinants of the dementia treatment gap in Singapore and their evolution over a decade

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In Singapore, despite significant public health and clinical initiatives, challenges persist in dementia diagnosis. Building on prior evidence of a reduction in the dementia treatment gap, this study examined the sociodemographic and clinical determinants of the treatment gap and how their associations evolved over a decade. This study utilised data from two nationally representative, cross-sectional surveys (Well-being of the Singapore Elderly) conducted in 2013 and 2023. The treatment gap was defined as the proportion of 10/66 dementia cases without a self-reported prior clinical diagnosis. The dementia treatment gap narrowed significantly, decreasing by 19.1% over the decade. However, improvements were largely driven by better diagnosis of moderate to severe dementia (25.3% of treatment gap attributable to Coefficients); in contrast, Coefficients were negative for no/questionable (−10.7%) and mild (−15.1%) dementia, indicating gaps in the diagnosis of early-stage dementia leading to the treatment gap. Over the past decade, Singapore has successfully narrowed its dementia treatment gap, primarily by mitigating socioeconomic barriers and enhancing the detection of moderate-to-severe cases.

Keywords 10/66 dementia, Early diagnosis, Decomposition analysis, Treatment gap, Singapore

Dementia represents one of the most significant global health and social challenges of the 21st century. The World Health Organization estimated that in 2021, over 55 million people worldwide were living with dementia and this figure was projected to increase to 78 million by 2030 and reach 139 million by 2050¹. Despite the increasing prevalence, a substantial “treatment gap” persists, wherein a majority of individuals with dementia do not receive a formal diagnosis or access to care and support services. For the purpose of this study, the term “treatment gap” refers to the proportion of individuals who meet epidemiological criteria for dementia but report not receiving a prior clinical diagnosis, reflecting a diagnostic gap that limits access to treatment, care planning, and support services. While diagnostic delay and under-recognition are important contributors, the operational focus of the treatment gap is the absence of a recorded clinical diagnosis among individuals with dementia.

While estimates of the dementia treatment gap vary widely across regions, reflecting substantial heterogeneity in healthcare system capacity, service organization, population characteristics, methodological approaches used to determine the treatment gap, and sociocultural factors related to help-seeking^{2,3}, a meta-analysis by Lang et al.⁴ estimated that the prevalence rate of undiagnosed dementia was 61.7% globally. The rate of undiagnosed dementia was significantly higher in Asia (93.2%) as compared to that in Europe (58.2%) and the USA (60.7%)⁴. This diagnostic and care chasm prevents individuals from accessing potential treatments, receiving essential support, and engaging in advance care planning, leading to immense strain on families, communities, and healthcare systems.

The reasons for the treatment gap are complex and multifactorial, stemming from a multitude of barriers at the individual, healthcare provider, and broader health system levels. At the patient and caregiver level, stigma and misperceptions that cognitive decline is a normal part of aging rather than a medical condition often

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delay help-seeking^{5,6}. Caregiver denial and a desire to preserve the autonomy and independence of the people living with dementia (PLWD) have been cited as contributing factors to delayed or missed diagnosis⁷. From the healthcare provider's perspective, primary care physicians, often the first point of contact, face significant challenges, including insufficient training in dementia diagnostics, clinical uncertainty, lack of time during standard appointments to conduct comprehensive cognitive assessments, and difficulties in communicating the diagnosis or not feeling comfortable about communicating the diagnosis^{8,9}. Furthermore, health systems in many countries are fragmented and poorly configured to manage chronic, long-term conditions like dementia, resulting in poor coordination between primary, secondary, and social care services¹⁰.

Socio-demographic and clinical factors also play a significant role. Studies have found that individuals from lower-income backgrounds are less likely to access dementia screening, specialist care, or long-term support¹¹. Data from the Retirement and Health Survey revealed that a higher proportion of non-Hispanic Blacks and Hispanics were unaware of their condition, despite higher dementia prevalence among them, compared to non-Hispanic Whites¹². Individuals with lower education, living alone or in a care home, or without a close relative, were, on average, 3.1 years older when diagnosed with dementia compared with their counterparts¹³. Late-life depression can present with significant cognitive deficits, including memory loss, attention problems, and difficulty with decision-making. The overlap of the symptoms makes it challenging for clinicians to differentiate neurocognitive disorder from late-life depressive disorders, leading to delayed diagnosis of dementia¹⁴.

Singapore, a cosmopolitan city-state in Southeast Asia, provides an informative setting to examine changes in the dementia treatment gap. As a rapidly ageing, multi-ethnic city-state with good healthcare coverage, Singapore has invested substantially over the past decade in improving dementia awareness, primary care capability building, establishing memory services in polyclinics^{15,16}, and community-based support under the national dementia strategies and the Community Mental Health Masterplan. At the same time, population ageing, socio-cultural factors, and health system challenges continue to place pressure on diagnostic capacity¹⁷. Evaluating whether these system-level investments have translated into measurable reductions in the treatment gap and identifying which socio-demographic and clinical factors continue to shape diagnostic inequities are relevant to health system planning and policy prioritisation. Building on our previous article¹⁸ that demonstrated a significant reduction in Singapore's dementia treatment gap over the past decade, the present study leverages nationally representative data from two distinct time points over 10 years and aims to (i) characterise the shifts in the distribution of key socio-demographic and clinical factors of individuals with and without a dementia diagnosis over time; (ii) examine how associations between these factors and the dementia treatment gap have evolved; and (iii) examine whether the previously observed reduction in the treatment gap is attributable to changes in population composition or changes in associations, to inform future strategies for more equitable dementia treatment access.

Methods

Study design and data source

This study utilised data from two nationally representative cross-sectional surveys in Singapore: the Well-being of the Singapore Elderly studies, conducted in 2012–2013 and 2022–2023 (WiSE 2013 and WiSE 2023, respectively). Both surveys aimed to estimate the prevalence and correlates of dementia and other mental disorders among adults aged 60 years and above, including those living in the community and long-term care facilities^{18,19}. The sampling frame (administrative database used), sampling methodology, and questionnaires used were similar across the two studies.

Stratified random sampling was employed in both waves based on the national registry of citizens and permanent residents, with oversampling of the oldest-old and minority ethnic groups to ensure robust subgroup analyses. Informed consent was obtained from all participants and their informants prior to the interview. Informants were family members or friends who, according to the older adult or other household members, “knew the older adult best”. Informants were eligible for the study if they were Singapore residents and aged 21 years and above. Informants did not need to reside with the older adult but had to be someone who could provide the most precise and detailed account of the older adult's health conditions and service use. In WiSE 2013, 142 of 2529 participants had no informant, and in WiSE 2023, 209 of 1993 had no informant. Participants without an informant were more likely to be younger, male, Chinese, to have higher educational attainment and income, to be employed, and not married/cohabiting. For older adults who lacked the capacity to provide informed consent, written consent was obtained from a legally authorised representative or next of kin. Verbal assent was sought from the participants who lacked capacity to provide informed consent, and interviews were discontinued if distress or dissent was expressed at any point. Ethical approval for the WiSE studies was obtained from the National Healthcare Group Domain-Specific Review Board and the SingHealth Centralized Institutional Review Board (DSRB References: 2012/00334, dated 6 June 2012 and 2020/01400, dated 18 May 2021). All methods described were performed in accordance with the recommendations in the World Medical Association Declaration of Helsinki and institutional standard operating procedures for research.

Study population

The analytical sample comprised older adults from both surveys who met the 10/66 Dementia Research Group diagnostic criteria for dementia. The 10/66 dementia diagnostic algorithm applies a probabilistic model that integrates data from the Community Screening Instrument for Dementia (CSI-D), the CERAD 10-word list recall task, and the Geriatric Mental State (GMS) examination (described in the subsequent section). The weighted coefficients used in the model were derived from training datasets from multiple international studies conducted by the 10/66 Dementia Research Group. Individuals are classified as having dementia when the predicted probability exceeds a predefined cut-off. The 10/66 diagnosis has been extensively validated across diverse cultural and educational settings, including Singapore^{19,20}. It has been particularly effective in diagnosing

dementia cases in Asia, can be administered by trained lay interviewers, and is available in multiple languages²⁰. Only participants with complete dementia diagnosis data, which included informant data, were retained.

Participant questionnaires

Assessment of dementia and mental disorders

Dementia status was determined using the 10/66 diagnostic algorithm, which incorporates the following standardised assessments:

The Geriatric Mental State (GMS) interview is a semi-structured tool that, through the Automated Geriatric Examination for Computer Assisted Taxonomy (AGECAT) algorithm, identifies conditions as organicity (probable dementia), depression, anxiety, and psychosis and classifies them across five levels of psychopathology — ranging from 0 (non-case) to 5 (severe case)²¹.

The Community Screening Instrument for Dementia (CSI'D)²² includes cognitive tasks such as the animal-naming verbal fluency test from the Consortium to Establish a Registry for Alzheimer's Disease (CERAD) and a modified 10-word list learning task with delayed recall^{23,24}. These assessments contribute to a composite global cognitive score (COGSCORE), which is a weighted total score reflecting the participant's cognitive performance.

An informant version of the CSI'D²² was also administered to capture the informant's perspective on the respondent's cognitive and functional decline. This generates an unweighted Relationship Score (RELScore) based on informant-reported changes.

Determination of treatment gap

To assess the treatment gap, participants and/or their informants were asked whether a doctor had ever diagnosed the participant with dementia or memory problems. Individuals who met the 10/66 criteria but lacked a reported prior clinical diagnosis were classified as cases of clinically undiagnosed dementia.

The treatment gap was operationalized as follows: Number of individuals with undiagnosed dementia / Total number of individuals with dementia × 100.

Healthcare utilisation

Healthcare utilisation data were obtained from respondents and their informants using an adapted version of the Client Service Receipt Inventory (CSRI)²⁵, which contains questions about specific community, hospital, and informal care services used during the three months preceding the interview. For this study, we determined whether they had contacts with doctors from three types of healthcare organisations (i.e., subsidised primary care clinics (polyclinics), restructured hospitals, and private hospitals/clinics) in the last three months. Information on whether participants had sought help at accident and emergency services and had been hospitalised in the past 3 months was also sought, respectively. Lastly, participants and their caregivers were asked about regular attendance at daycare centres.

Other measures

The severity of dementia in all participants was assessed using a computerized operationalization of the Clinical Dementia Rating (CDR) scale²⁶. The CDR is based on a scale of 0–3: (0) no dementia, (0.5) questionable dementia, (1) mild dementia, (2) moderate dementia, and (3) severe dementia. As no individuals who scored (0) were given a doctor diagnosis, and all individuals who scored (3) were given a doctor diagnosis in the dataset, the groups were collapsed into: (i) no/questionable dementia, (ii) mild dementia, and (iii) moderate/severe dementia to ensure convergence in subsequent regression analyses. As part of the background socio-demographic and risk factor questionnaire, the interviewer read a chronic conditions checklist to the respondents. The respondents were asked whether they had any of the following chronic conditions diagnosed by a medical doctor: hypertension, diabetes, heart problems, Transient Ischaemic Attack (TIA), Traumatic Brain Injury (TBI), and stroke. They were also asked whether they had any hearing or visual impairment.

Depression and anxiety were determined using the GMS diagnosis. Stage 1 diagnosis captures severity levels 3 and above (severely affected and very severely affected) as depression and anxiety (cases), while levels 1 and 2 (subcases) are classified as subsyndromal depression and anxiety²⁷. For this study, those scoring ≥ 1 were classified as having depression/subsyndromal depression and anxiety/subsyndromal anxiety. This threshold was selected to capture both syndromal and subsyndromal symptom burden as potential contributors to healthcare contact and diagnostic pathways, rather than for clinical diagnostic classification. Interviewers also obtained information on the older adult's age, gender, ethnicity, marital status, educational level, living arrangements, personal monthly income, employment status, and family history of dementia using a structured questionnaire.

Informant questionnaires

The World Health Organization's Self-Reporting Questionnaire (SRQ-20)²⁸, a 20-item instrument, was used to screen for non-psychotic symptoms such as depression, anxiety, and psychosomatic complaints experienced over the past two weeks. Each item is answered with a "yes" or "no," and the questionnaire was administered to caregivers by trained interviewers. The total score ranges from 0 to 20, with a score ≥ 8 indicating psychiatric morbidity.

Informants were asked about the older adult's care needs, and answers were categorised as 'Does not need Care' and 'Needs care', which comprised 'Needs care much of the time' as well as 'Needs care some of the time'.

Statistical analysis

Data from WiSE 2013 and WiSE 2023 were combined into a single analytic dataset with a survey-wave indicator variable. Analyses examining differences across waves incorporated the survey-wave indicator where appropriate to formally assess temporal changes. As identical questionnaires, sampling frames, and field procedures were

used in both surveys, no variable reconstruction was required. All variables were directly comparable across waves, and identical coding schemes were retained.

Post-stratification weights were derived separately for each survey wave to align the sample distribution to the corresponding national census population distribution (June 2011 for WiSE 2013 and June 2022 for WiSE 2023) by age group and ethnicity. To ensure comparability between waves when pooling the datasets, weights were rescaled within each wave so that the mean weight equalled 1. This preserves relative weighting while preventing artificial inflation of sample size in pooled analyses.

We first examined the distribution of socio-demographic characteristics in our overall sample over the two points across the decade. We then compared the distributions of socio-demographic characteristics, clinical factors, and healthcare utilisation between cases with clinically diagnosed and undiagnosed dementia and examined shifts in these distributions over the decade among cases with clinically undiagnosed dementia. Survey weights were incorporated using the R-packages “survey” (version 7.3–65), and strata was defined using the cross-classification of age group, ethnicity, and survey wave in general population. Wave-specific and subgroup analyses were conducted by subsetting the survey design object (e.g., restricting to 10/66-diagnosed dementia cases within each wave), thereby preserving the survey design structure in all inferential analyses. Descriptives of categorical variables are presented with frequency and proportion, and group differences were assessed using Rao-Scott adjusted chi-square tests to account for survey design.

Shifts in the treatment gap over the decade could be attributable to two components: compositional differences between the two waves among PLWD diagnosed by the 10/66 protocol, and differences in the effects of characteristics associated with doctor diagnosis. Therefore, we further examined shifts in the distribution of all factors over the decade among PLWD diagnosed by the 10/66 protocol and then conducted univariate robust Poisson regression to identify potential associated factors of the treatment gap. Weights were incorporated by subsetting the survey design object in general population. Robust Poisson regression was chosen over logistic regression to avoid overestimation of odds ratios in cases of common binary outcomes²⁹. Potential associated factors with doctor diagnosis were then simultaneously incorporated into subsequent multivariable nonlinear decomposition analysis to quantify their respective contributions to the shift in treatment gap over the decade³⁰. Decomposition analysis partitions change over time into components attributable to changes in composition (Endowments) and changes in effects (Coefficients). Due to the decrease in treatment gap over the decade in our study, a positive value of the Endowment component indicates a decrease in the prevalence of risk factors for the treatment gap or an increase in the prevalence of protective factors for the treatment gap, and a positive value of the Coefficient component indicates weakening associations between risk factors and the treatment gap or stronger associations between protective factors and the treatment gap. Multivariable nonlinear decomposition analysis was conducted using the Stata-command “mvdcmp” (version 3.0) in combination with “svyppoisson” within the survey design framework to ensure correct variance estimation. To restrict analyses to individuals diagnosed with dementia using the 10/66 protocol while preserving survey structure (as recommended in correspondence with the developer of mvdcmp), weights were set to zero for respondents without 10/66 dementia. This approach allowed the full survey design to be retained while limiting inference to the analytic subpopulation. Data cleaning and decomposition analysis were performed using Stata MP 19, and all other analyses were conducted using R 4.5.1.

Results

Socio-demographic characteristics of individuals in the overall sample

Table 1 compares the demographic characteristics of the general population in both 2013 and 2023. After weighting, the distribution of age and ethnicity in the sample conforms to that of the Singapore Census in 2011 and 2022, respectively, which remained relatively unchanged over the decade. However, education, employment status, and personal income in the population improved over time.

Socio-demographic, clinical, and healthcare utilization factors among doctor-diagnosed and doctor-undiagnosed dementia over the decade

Among individuals meeting the 10/66 criteria for dementia, several socio-demographic, clinical, and service-related factors differed between those with and without doctor-diagnosed dementia across both waves (Table 2). In 2013 and 2023, individuals with undiagnosed dementia were, more likely to have lower educational attainment (e.g., in 2013, 7.4% of those with undiagnosed dementia had secondary and higher education as compared to 23.8% of those with doctor-diagnosed dementia, while in 2023, 14.8% with undiagnosed dementia had secondary and higher education as compared to 16.5% with doctor-diagnosed dementia), more likely to have milder dementia severity (in 2013, 54.4% of undiagnosed cases had mild dementia compared to 43.7% of cases that were doctor diagnosed, while in 2023, 45.0% of undiagnosed cases had mild dementia as compared to 36.1% cases with diagnosed dementia), substantially less likely to attend day care services (only 2.1% of those with undiagnosed dementia attended day care centres in both waves as compared to 15.3% and 23.7% of those with diagnosed dementia in the two waves), and had lower care needs (80.6% and 64.2% of undiagnosed cases had care needs, compared with over 95% of diagnosed individuals requiring care in both years), as compared to those with diagnosed dementia.

Changes in the distribution and associations of socio-demographic, clinical, and healthcare utilization factors and treatment gap for dementia between 2013 and 2023

Figure 1 compares significant shifts in the distribution of socio-demographic, clinical, and healthcare utilization factors and their association with dementia treatment gap over a decade among PLWD diagnosed by the 10/66 protocol.

		WiSE 2013			WiSE 2023		
		Frequency	Unweighted %	Weighted %	Frequency	Unweighted %	Weighted %
Age (years)	60–74	1469	58.1	75.0	1088	54.6	74.9
	75–84	662	26.2	19.5	573	28.8	18.8
	85+	398	15.7	5.5	332	16.7	6.3
Female	No	1098	43.4	44.0	900	45.2	47.0
	Yes	1431	56.6	56.0	1093	54.8	53.0
Ethnicity	Chinese	1012	40.0	84.5	678	34.0	82.9
	Malay	745	29.5	9.4	699	35.1	10.6
	Indian	772	30.5	6.1	616	30.9	6.5
Education	None	511	20.3	16.7	216	10.9	7.3
	Below primary	614	24.4	24.0	389	19.6	20.9
	Primary	636	25.3	25.0	565	28.4	26.8
	Secondary	505	20.1	22.2	539	27.1	27.9
	Tertiary	248	9.9	12.0	277	13.9	17.2
Employment	Employed	676	27.1	33.9	632	31.8	42.3
	Unemployed	32	1.3	1.6	35	1.8	1.3
	Inactive	1790	71.7	64.6	1320	66.4	56.4
Personal income	No income	549	21.8	18.7	337	17.0	19.1
	SG\$ 1 to 1000	1226	48.6	42.6	848	42.8	33.1
	SG\$ 1001 to 3000	597	23.7	30.9	610	30.8	34.5
	SG\$ above 3000	152	6.0	7.8	188	9.5	13.2
Marital status	Single	134	5.3	8.0	113	5.7	9.2
	Married/cohabiting	1461	57.8	64.0	1160	58.3	65.8
	Widowed/divorced/separated	932	36.9	28.0	716	36.0	24.9

Table 1. Distribution of demographics in the general population over the decade.

Among socio-demographic predictors, a higher proportion of older adults had higher personal incomes and lived alone in 2023, while the distribution of other factors remained relatively unchanged over the decade. Older adults with primary education were nearly twice as likely to have a treatment gap in 2023 compared to those with no education (IRR 1.97, 95% CI: 1.25–3.10), whereas the association was weaker in 2013 ($p=0.02$). Employment history also shifted: in 2013, manual workers had a significantly higher likelihood of being associated with a treatment gap (IRR 1.87, 95% CI: 1.26–2.78) compared to non-manual workers, but by 2023, this disadvantage had attenuated ($p=0.01$).

The distribution of clinical factors did not change significantly over the decade. Individuals with a need for care had a lower likelihood of having a treatment gap, and this association strengthened over time (IRR 0.68, 95% CI: 0.60–0.77 in 2013 vs. 0.47, 95% CI: 0.35–0.65 in 2023; $p=0.04$). Compared to those with no/questionable dementia, individuals with moderate/severe dementia had a lower likelihood of a treatment gap in 2023 (IRR 0.41, 95% CI: 0.27–0.61 in 2013 vs. 0.13, 95% CI: 0.05–0.30; $p=0.02$). Finally, those with doctor-diagnosed hypertension had a lower likelihood of having a treatment gap for dementia in 2013 (IRR 0.78, 95% CI: 0.66–0.92); however, no association was identified in 2023 (IRR 1.42, 95% CI: 0.85–2.37; $p=0.03$).

Decomposition analysis adjusting for all variables and examining their contribution to the change in treatment gap over the decade

The decomposition analysis indicated that changes in the dementia treatment gap between 2013 and 2023 were almost equally attributable to Endowments (49.7%; Endowment component = 0.092, $p<0.001$) and Coefficients (50.3%; Coefficient component = 0.093, $p=0.03$). (Table 3)

Among socio-demographic factors, having no income contributed favourably (Coefficient component = 0.0175, 95% CI: 0.0005–0.0345, $p=0.04$, 9.47%), indicating a weakening association between lack of income and the treatment gap over time. Contacts with number of different types of healthcare providers presented a complex picture: Contact with one provider was unfavorable (Coefficient component = -0.0454 , 95% CI: -0.0889 to -0.0020 , $p=0.04$; -24.6%), as was contact with two providers (Coefficient component = -0.0293 , 95% CI: -0.0565 to -0.0022 , $p=0.03$; -15.9%). In contrast, contact with three providers contributed favourably (Coefficient component = 0.0103, 95% CI: 0.0006–0.0199, $p=0.04$; 5.6%). Disease severity, as measured by the CDR, similarly showed mixed effects: for *No/Questionable* dementia (Coefficient component = -0.0197 , 95% CI: -0.0354 to -0.0041 , $p=0.01$; -10.7%) as well as *Mild* dementia (Coefficient component = -0.0279 , 95% CI: -0.0482 to -0.0076 , $p=0.007$; -15.1%) Coefficients were unfavorable. In contrast, for *Moderate/Severe* dementia, both Endowments (Endowment component = 0.0176, 95% CI: 0.0073–0.0278, $p<0.001$; 9.5%) and Coefficients (Coefficient component = 0.0467, 95% CI: 0.0147–0.0787, $p=0.004$; 25.3%) contributed favourably, indicating that both shifts in prevalence and effects of severity reduced the treatment gap.

	WiSE 2013			WiSE 2023			P value*
	Undiagnosed	Diagnosed	P value	Undiagnosed	Diagnosed	P value	
Age (years)							
60–74	48 (28.9%)	12 (17.9%)	0.35	30 (37.3%)	10 (14.1%)	0.02	0.31
75–84	69 (41.3%)	31 (45.0%)		23 (28.6%)	36 (49.9%)		
85+	50 (29.8%)	26 (37.1%)		27 (34.1%)	26 (36.0%)		
Female							
No	60 (35.7%)	22 (31.2%)	0.58	27 (34.1%)	23 (31.6%)	0.79	0.85
Yes	108 (64.3%)	48 (68.8%)		52 (65.9%)	49 (68.4%)		
Ethnicity							
Chinese	139 (83.3%)	63 (90.1%)	0.02	65 (82.1%)	58 (80.4%)	0.87	0.42
Malay	20 (11.8%)	4 (5.4%)		8 (10.7%)	9 (12.0%)		
Indian	8 (4.9%)	3 (4.5%)		6 (7.2%)	5 (7.6%)		
Educational attainment							
None	67 (40.0%)	22 (32.5%)	0.01	18 (22.2%)	24 (33.1%)	0.02	0.13
Below primary	43 (25.7%)	20 (29.6%)		26 (32.5%)	32 (43.8%)		
Primary	45 (26.9%)	10 (14.1%)		24 (30.4%)	5 (6.6%)		
Secondary and above	12 (7.4%)	16 (23.8%)		12 (14.8%)	12 (16.5%)		
Personal income							
No income	80 (48.3%)	50 (71.8%)	0.01	23 (29.6%)	31 (43.4%)	0.38	0.00
SG\$ 1 to 1000	78 (46.8%)	17 (23.7%)		38 (49.1%)	30 (42.0%)		
Above SG\$ 1000	8 (4.9%)	3 (4.4%)		16 (21.3%)	11 (14.6%)		
Types of employment							
Non-manual	20 (12.5%)	25 (36.5%)	0.00	19 (24.4%)	12 (16.9%)	0.19	0.05
Manual	107 (66.3%)	22 (32.0%)		50 (65.1%)	43 (59.9%)		
Never worked	34 (21.3%)	22 (31.5%)		8 (10.6%)	17 (23.3%)		
Marital status							
Never/previously married	92 (55.8%)	44 (65.4%)	0.28	42 (52.9%)	42 (58.8%)	0.57	0.74
Married/cohabiting	73 (44.2%)	23 (34.6%)		37 (47.1%)	30 (41.2%)		
Living alone							
No	164 (97.9%)	65 (93.6%)	0.09	76 (96.2%)	55 (75.5%)	0.00	0.44
Yes	4 (2.1%)	4 (6.4%)		3 (3.8%)	18 (24.5%)		
Family history of dementia							
No	152 (95.8%)	43 (72.8%)	0.00	62 (86.8%)	49 (74.8%)	0.16	0.04
Yes	7 (4.2%)	16 (27.2%)		10 (13.2%)	17 (25.2%)		
Contact with types of healthcare providers in last three months							
0	37 (21.9%)	17 (24.4%)	0.21	15 (19.0%)	25 (35.0%)	0.04	0.14
1	100 (60.0%)	32 (45.8%)		39 (49.5%)	24 (33.2%)		
2	29 (17.2%)	20 (28.5%)		25 (31.2%)	18 (25.2%)		
3	1 (0.9%)	1 (1.4%)		0 (0.3%)	5 (6.6%)		
Attend day centre regularly in last three months							
No	164 (97.9%)	59 (84.7%)	0.01	77 (97.9%)	55 (76.3%)	0.00	0.98
Yes	4 (2.1%)	11 (15.3%)		2 (2.1%)	17 (23.7%)		
Visited ED in the last three months							
No	152 (91.1%)	58 (82.8%)	0.10	69 (87.6%)	54 (76.5%)	0.14	0.43
Yes	15 (8.9%)	12 (17.2%)		10 (12.4%)	17 (23.5%)		
Admitted to hospital in the last three months							
No	147 (87.9%)	59 (84.6%)	0.55	68 (85.7%)	56 (77.9%)	0.33	0.71
Yes	20 (12.1%)	11 (15.4%)		11 (14.3%)	16 (22.1%)		
Clinical dementia rating							
No/questionable	57 (34.2%)	6 (9.2%)	0.00	38 (47.7%)	3 (3.6%)	0.00	0.23
Mild	91 (54.4%)	30 (43.7%)		36 (45.0%)	26 (36.1%)		
Moderate/severe	19 (11.4%)	33 (47.1%)		6 (7.4%)	44 (60.3%)		
TBI							
No	154 (92.6%)	56 (80.2%)	0.02	77 (97.8%)	60 (84.7%)	0.01	0.12
Yes	12 (7.4%)	14 (19.8%)		2 (2.2%)	11 (15.3%)		
Doctor diagnosed hypertension							
Continued							

	WiSE 2013			WiSE 2023			P value*
	Undiagnosed	Diagnosed	P value	Undiagnosed	Diagnosed	P value	
No	59 (35.4%)	12 (16.6%)	0.00	16 (20.8%)	24 (34.2%)	0.15	0.07
Yes	108 (64.6%)	58 (83.4%)		63 (79.2%)	47 (65.8%)		
Doctor diagnosed diabetes							
No	114 (69.1%)	51 (73.0%)	0.62	52 (66.0%)	47 (66.5%)	0.96	0.70
Yes	51 (30.9%)	19 (27.0%)		27 (34.0%)	24 (33.5%)		
Heart problems							
No	132 (79.0%)	53 (76.6%)	0.72	64 (83.7%)	56 (83.8%)	0.99	0.49
Yes	35 (21.0%)	16 (23.4%)		12 (16.3%)	11 (16.2%)		
Transient ischemic attacks							
No	155 (96.4%)	65 (94.5%)	0.55	74 (93.8%)	67 (95.1%)	0.76	0.46
Yes	6 (3.6%)	4 (5.5%)		5 (6.2%)	3 (4.9%)		
Stroke							
No	122 (73.0%)	42 (61.3%)	0.15	61 (77.1%)	54 (74.4%)	0.77	0.62
Yes	45 (27.0%)	27 (38.7%)		18 (22.9%)	19 (25.6%)		
Hearing impairment							
No	96 (57.7%)	43 (62.2%)	0.59	56 (71.1%)	46 (63.7%)	0.43	0.10
Yes	70 (42.3%)	26 (37.8%)		23 (28.9%)	26 (36.3%)		
Eyesight problems							
No	81 (48.5%)	32 (47.1%)	0.88	46 (58.8%)	40 (55.3%)	0.74	0.24
Yes	86 (51.5%)	36 (52.9%)		33 (41.2%)	32 (44.7%)		
Depression/subsyndromal depression							
No	114 (68.1%)	58 (83.8%)	0.04	56 (71.4%)	52 (71.8%)	0.97	0.68
Yes	53 (31.9%)	11 (16.2%)		23 (28.6%)	20 (28.2%)		
Anxiety/subsyndromal anxiety							
No	124 (74.0%)	62 (89.6%)	0.02	53 (66.8%)	64 (88.9%)	0.02	0.37
Yes	44 (26.0%)	7 (10.4%)		26 (33.2%)	8 (11.1%)		
Caregiver distress - SRQ							
No	146 (87.3%)	63 (91.4%)	0.39	75 (94.8%)	62 (86.2%)	0.19	0.18
Yes	21 (12.7%)	6 (8.6%)		4 (5.2%)	10 (13.8%)		
Care needs							
No	33 (19.4%)	1 (1.3%)	0.00	28 (35.8%)	3 (4.6%)	0.00	0.04
Yes	135 (80.6%)	69 (98.7%)		51 (64.2%)	69 (95.4%)		

Table 2. Weighted distribution of socio-demographic, clinical, and healthcare utilization factors between doctor-diagnosed and undiagnosed dementia among individuals diagnosed with 10/66 dementia. *P value of the interaction term between wave and corresponding factors in the robust Poisson model.

Discussion

This study provides a comprehensive analysis of Singapore's dementia treatment gap over a decade, revealing significant progress as well as persistent challenges. By comparing nationally representative data from 2013 to 2023, we found that the treatment gap for dementia narrowed substantially, by 19.1%, from 70.6 to 51.5%¹⁸, against a backdrop of changing socio-demographic profiles of older adults in Singapore. The profile of older adults in Singapore has undergone significant evolution over the past decade. In 2023, women comprised a larger share of the older adult population compared to men, reflecting global longevity trends³¹. The proportion of the oldest-old increased, while, on average, older adults attained higher levels of education, were more likely to be employed, and reported higher personal monthly incomes over the decade^{32,33}.

A key positive finding is the reduction in socioeconomic barriers to the treatment gap. In 2013, individuals with a history of manual labour were significantly more likely to remain undiagnosed, consistent with international literature showing that socioeconomic disadvantage is a significant barrier to dementia diagnosis, leading to a treatment gap^{11,34,35}. However, by 2023, these associations had attenuated, suggesting that the link between economic barriers and treatment gap is no longer discernible. The results of the decomposition analysis showed a weakening association between having no income and treatment gap over time, further strengthening the evidence that the association between economic barriers and the treatment gap has diminished. In Singapore, these shifts may reflect the impact of national health financing schemes and policy initiatives, including the Community Mental Health Masterplan (leading to the creation of subsidised memory clinics in polyclinics, where residents identified as at risk of dementia can receive care at more affordable rates), CHAS subsidies, and the Pioneer Generation Package, which have broadened access to primary and specialist care for older adults^{36,37}. Together, these findings suggest that equity in dementia diagnosis and treatment is improving in Singapore.

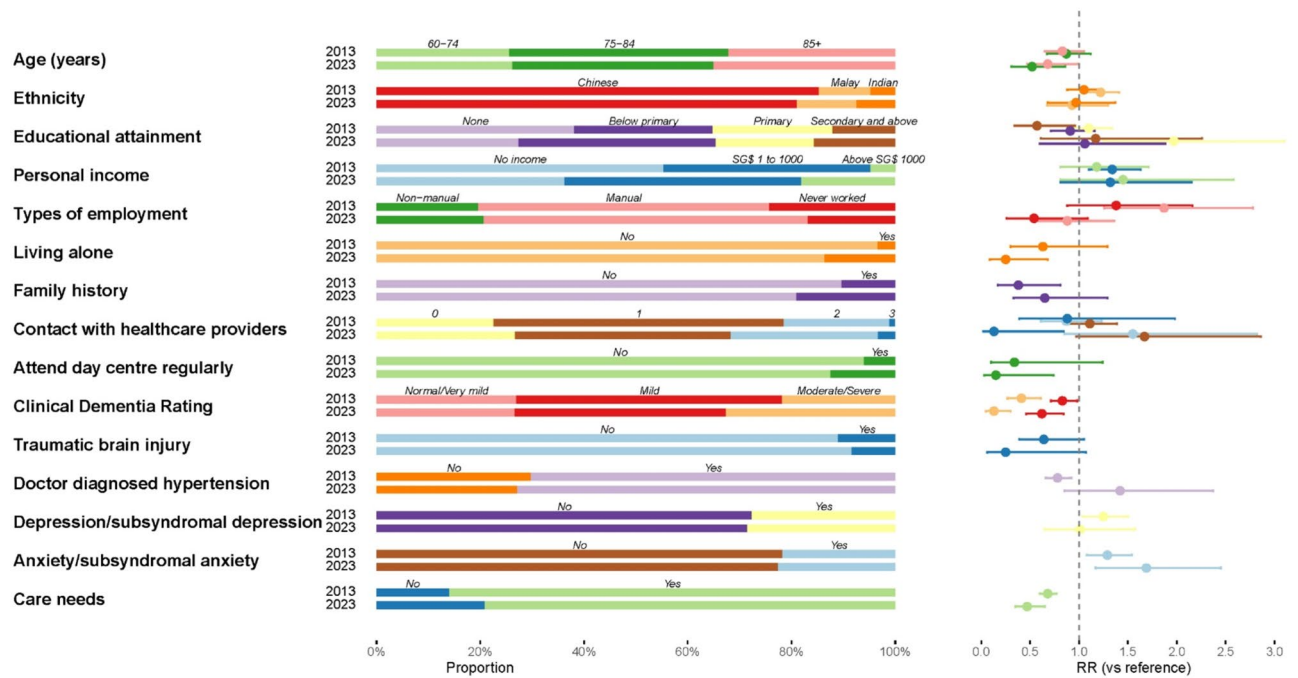


Fig. 1. Significant changes in the distribution of socio-demographic, clinical, and health utilization factors and their associations with treatment gap.

However, the role of education presented a more complex picture. Individuals with a primary education were nearly twice as likely to be undiagnosed in 2023 compared to those with no education, a disparity that was not evident in 2013. This group may occupy a “middle ground”: while they are less likely to be reached by social or community support systems that often prioritize the most vulnerable with no formal education, they may also lack the health literacy, financial resources, or confidence to seek medical evaluation proactively, unlike their higher-educated peers. International evidence supports the role of education in shaping dementia help-seeking, with lower educational attainment linked to reduced recognition, delayed presentation, and poorer access to diagnostic services, all of which contribute to the treatment gap^{38,39}. In Singapore, this finding may partly reflect generational patterns, as older cohorts with primary education often have limited English proficiency and may not fully benefit from national awareness campaigns or health information delivered through formal channels⁴⁰. Tailoring dementia literacy initiatives to the linguistic and cultural contexts of this group, by leveraging local languages spoken in Singapore, grassroots networks, and primary care engagement, will be crucial in further narrowing the treatment gap.

Despite the concerted efforts of the Government to promote early diagnosis and management of dementia¹⁵, our study found significant differences in the treatment gap based on dementia severity. The healthcare system has become significantly more effective at identifying individuals with moderate to severe dementia, as evidenced by the increased prevalence of moderate/severe dementia and its stronger association with lower treatment gap in the decomposition analysis and the strengthening association between the need for care and lower treatment gap. However, the reduction of treatment gap for individuals with no/questionable and mild dementia achieved less improvement when compared to the group with moderate to severe dementia. This indicates a critical gap in the detection of early-stage dementia. It suggests that while the system is adept at recognising evident, functionally impairing symptoms, it is unable to diagnose dementia at an early stage and misses the subtle cognitive changes of early disease, which may either not be observed by the family, or may attribute it to normal ageing. This pattern is not unique to our health system. Globally, dementia is often only diagnosed once functional symptoms are apparent, while the subtle cognitive and functional changes in its early stages go undetected⁴¹. Efforts to develop blood-based biomarkers (e.g., amyloid and tau markers) aim to shift diagnosis earlier, improve accessibility to care, and reduce the treatment gap, although technical, interpretative, standardisation, and implementation challenges remain^{42,43}.

Previous research aligns with our findings. A meta-analysis by Lang et al.⁴ found that dementia detection rates consistently increased with greater disease severity across studies. Sternberg et al.⁴⁴ similarly observed that individuals with no or only minor physical or functional difficulties were less likely to consult a general practitioner regarding memory concerns, which may in turn contribute to higher rates of the treatment gap within this group. A qualitative study of primary care physicians identified insufficient consultation time as a key barrier to reducing treatment gap. Physicians reported that limited time often resulted in psychosocial issues and behavioral disturbances being overlooked until they became severe, a pattern one physician described as “reactive care.” Consequently, diagnoses would be delayed until problems could no longer be ignored or managed by family members⁴⁵, and correspondingly, would be under-detected and under-treated by primary care physicians until they reached a more problematic and advanced stage.

	Endowment component (E)	95% CI lower	95% CI upper	p value	Percentage	Coefficient component (C)	95% CI lower	95% CI upper	p value	Percentage
Total	0.09167	0.04026	0.14307	<0.001	49.7	0.09292	0.01139	0.17446	0.03	50.3
Age group										
60–74	0.00008	-0.00082	0.00098	0.86	0.04	-0.00142	-0.00898	0.00614	0.71	-0.77
75–84	-0.00058	-0.00153	0.00037	0.23	-0.32	0.00839	-0.00600	0.02277	0.25	4.54
85+	-0.00087	-0.00287	0.00113	0.39	-0.47	-0.00530	-0.01727	0.00668	0.39	-2.87
Ethnicity										
Chinese	-0.00148	-0.00327	0.00032	0.11	-0.80	-0.01445	-0.03813	0.00923	0.23	-7.83
Malay	-0.00071	-0.00154	0.00012	0.09	-0.39	0.00054	-0.00370	0.00479	0.80	0.30
Indian	0.00004	-0.00123	0.00130	0.96	0.02	0.00109	-0.00181	0.00400	0.46	0.59
Education										
None	0.00278	-0.00223	0.00779	0.28	1.51	0.01332	-0.00142	0.02805	0.08	7.21
Below primary	-0.00068	-0.00496	0.00359	0.75	-0.37	0.00575	-0.00821	0.01971	0.42	3.11
Primary	0.00411	-0.00074	0.00897	0.10	2.23	0.00202	-0.00541	0.00946	0.59	1.10
Secondary and above	0.00687	-0.00264	0.01637	0.16	3.72	-0.01281	-0.02673	0.00111	0.07	-6.94
Personal income										
No income	0.00001	-0.00826	0.00827	1.00	0.00	0.01748	0.00045	0.03452	0.04	9.47
SG\$ 1 to 1000	0.00029	-0.00239	0.00296	0.83	0.16	-0.01028	-0.03127	0.01072	0.34	-5.57
Above SG\$ 1000	-0.00075	-0.01060	0.00909	0.88	-0.41	-0.00365	-0.01122	0.00391	0.34	-1.98
Employment type										
Non-manual	0.00039	-0.00119	0.00197	0.63	0.21	0.00337	-0.00854	0.01527	0.58	1.82
Manual	-0.00157	-0.00332	0.00018	0.08	-0.85	0.01168	-0.01178	0.03515	0.33	6.33
Never worked	-0.00136	-0.00451	0.00178	0.40	-0.74	-0.00593	-0.01518	0.00332	0.21	-3.21
Living alone	0.00812	-0.01613	0.03237	0.51	4.40	-0.00151	-0.02122	0.01820	0.88	-0.82
Family history of dementia	0.01605	-0.00547	0.03757	0.14	8.70	-0.00632	-0.03190	0.01925	0.63	-3.43
Contact with types of healthcare providers in last three months										
0	-0.00227	-0.00600	0.00146	0.23	-1.23	-0.01755	-0.04137	0.00627	0.15	-9.51
1	0.01133	-0.00018	0.02285	0.05	6.14	-0.04544	-0.08886	-0.00203	0.04	-24.62
2	-0.00078	-0.00716	0.00561	0.81	-0.42	-0.02934	-0.05652	-0.00216	0.03	-15.90
3	0.00392	-0.00109	0.00893	0.13	2.12	0.01027	0.00062	0.01992	0.04	5.56
Attend day centre regularly in last three months	0.02759	-0.01702	0.07219	0.23	14.95	0.00868	-0.04253	0.05989	0.74	4.70
Clinical dementia rating										
Normal/very mild	0.00172	0.00085	0.00258	<0.001	0.93	-0.01973	-0.03537	-0.00410	0.01	-10.69
Mild	0.00444	-0.00076	0.00965	0.09	2.41	-0.02787	-0.04816	-0.00758	0.007	-15.10
Moderate/severe	0.01755	0.00728	0.02782	<0.001	9.51	0.04667	0.01466	0.07868	0.004	25.28
Traumatic brain injury	-0.00203	-0.00580	0.00174	0.29	-1.10	0.00467	-0.01014	0.01947	0.54	2.53
Doctor diagnosed hypertension	0.00010	-0.00029	0.00049	0.61	0.05	-0.01840	-0.06334	0.02654	0.42	-9.97
Depression/subsyndromal depression	0.00041	-0.00110	0.00192	0.60	0.22	0.00407	-0.01133	0.01947	0.60	2.20
Anxiety/subsyndromal anxiety	0.00085	-0.00201	0.00372	0.56	0.46	-0.00318	-0.01203	0.00567	0.48	-1.72
Care needs	-0.00189	-0.00578	0.00200	0.34	-1.02	0.00020	-0.04604	0.04644	0.99	0.11
Constant						0.17792	0.02721	0.32863	0.02	96.39

Table 3. Multivariable nonlinear decomposition analysis of the change in treatment gap of dementia between 2013 and 2023. Bold values indicate significance ($p < 0.05$).

The association between the treatment gap and healthcare contact reveals a worrying delay in the diagnostic pathway. While engagement with three different types of healthcare providers was strongly associated with receiving a diagnosis, contact with only one or two provider types was linked to a widening treatment gap. This may indicate that routine visits, likely representing visits to primary care clinics or non-specialist hospital departments, constitute missed opportunities for timely detection. Such encounters are often the first and most frequent points of contact for older adults and their families, yet they may not trigger further cognitive assessment or specialist referral⁴⁶. This aligns with well-documented challenges faced by primary care physicians, including limited consultation time, competing clinical priorities, and insufficient training in dementia recognition and management^{7,47}. A study by Mitchell et al.⁴⁸ found that while clinicians in primary care were able to identify about 75% of dementia cases, fewer than 40% were annotated in the medical records. Detection rates were significantly lower for Mild Cognitive Impairment (MCI), with approximately 45% of cases recognized by GPs and only about 11% recorded in medical notes. Overall, GPs faced challenges with identifying and recording

MCI. The findings underscore the importance of strengthening dementia competencies in primary care and creating clear referral pathways to specialist services. Without such system-level reinforcement, the gains achieved in diagnosing moderate-to-severe dementia will be undermined by a persistent and possibly growing gap in identifying cases at earlier, more treatable stages.

The primary strength of this study lies in its use of two large, methodologically consistent, and nationally representative surveys conducted a decade apart, which enables a robust comparison of the dementia treatment gap across time. The application of nonlinear decomposition analysis provides deeper insight into the drivers of this change. However, the serial cross-sectional design precludes causal inference at the individual level. Ascertainment of prior clinical diagnosis relied on participant or informant report and may be subject to recall and health literacy bias. A limitation of this study is that 10/66 dementia diagnosis requires informant data and hence participants without informants, were excluded from this analysis. These participants who were more likely to be younger, male, more educated, and not married, may be associated with differences in healthcare access and normal cognition or milder cognitive impairment (they were assessed to be capable of providing informed consent). Thus, the treatment gap estimates could have been lower if these participants were included in the analysis. While, the findings are directly informative for Singapore's health system and policy context, the conceptual insights regarding socioeconomic differences, disease severity, and association with healthcare utilisation may nevertheless be relevant to other ageing societies with comparable healthcare structures.

Conclusions

Over the past decade, Singapore has made significant progress in closing the dementia treatment gap, particularly through reducing socioeconomic barriers and enhancing the diagnosis of moderate and severe cases. However, this contrasts with a widening gap for individuals in the early stages of the disease. To address this gap, primary care providers, as well as staff of active ageing centres and other voluntary organisations serving older adults, must be provided with the relevant tools and training in dementia literacy to identify subtle cognitive changes. Singapore can build further on its achievements and ensure that all individuals with dementia receive a timely diagnosis, allowing them and their families to access essential care and support.

Data availability

The WISE surveys that support the findings of this study are available upon request from the corresponding author.

Received: 25 November 2025; Accepted: 19 March 2026

Published online: 01 April 2026

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Author contributions

MS wrote the first draft of the article, developed the study protocol, trained the interviewers, provided clinical input, and supervised the interviewers; KN led the analyses, prepared the figures and tables and provided input into the article; PVA was the project manager, trained interviewers, and provided input into the article; EA supported the data analysis, ran the algorithms and provided input into the article; AJ was involved in interviewer training, field work supervision and provided input into the article; BYC and BT were responsible for maintenance of the database, data quality checks and provided input into the article; HM and FY provided clinical support to participants during the interview, provided clinical input and provided input into the article; JV contributed to the protocol, interviewer training and provided input into the article LLN and SAC were involved in securing the grant funding, writing the proposal, training interviewers and provided input into the article. All authors have seen the final draft and were agreeable to the submission.

Funding

The study was funded by a grant from the Ministry of Health, Singapore. Role of the funding source: The sponsor did not have any role in the study design; in the collection, analysis, and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Declarations

Competing interests

The authors declare no competing interests.

Consent statement

All the participants or their legally approved representatives provided written informed consent.

Additional information

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1038/s41598-026-45491-4>.

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