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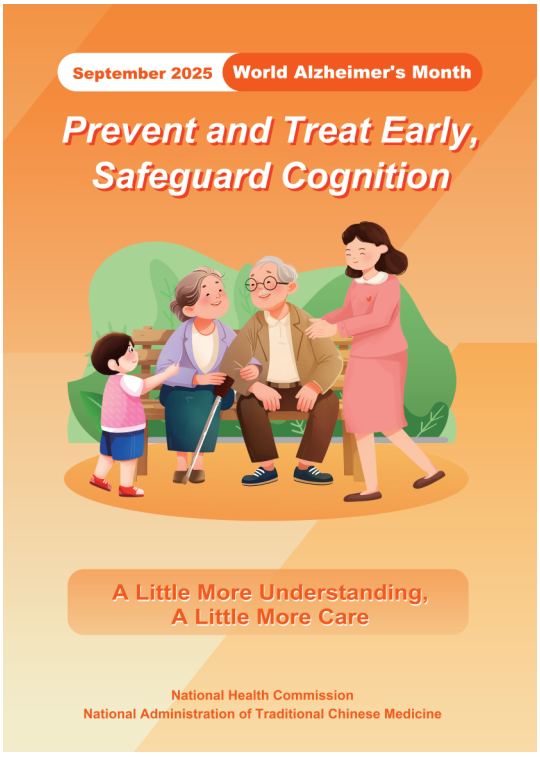

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Perspectives

Advancing Dementia Care Continuity: The 3A (Awareness, Attitude, Action) Framework

Huali Wang[1,#]

ABSTRACT

In the context of World Alzheimer's Month 2025, this perspective article examines the current state of care continuity for people living with dementia in China and identifies critical gaps in this domain. The article further reviews existing global dementia action plans, highlighting the strategic approaches outlined in China's National Action Plan on Response to Dementia (2024–2030). To transform knowledge into meaningful change, this perspective proposes the 3A approach — Awareness, Attitude, and Action — as a comprehensive guiding framework to strengthen and advance the continuum of care.

As the world observes *World Alzheimer's Month 2025* under the theme *"Ask About Dementia, Ask About Alzheimer's"*, the global community confronts an urgent imperative to address dementia as one of the most formidable public health challenges of our era. More than 55 million people worldwide currently live with dementia, with projections indicating this number will nearly double every two decades. China, experiencing rapid population aging, shoulders a particularly substantial burden, with an estimated 16 million people affected by dementia in 2021 (*1*–*2*).

The impact extends far beyond those receiving a diagnosis. Caregivers — predominantly family members — endure profound psychological, physical, and financial strain, with nearly 40% experiencing anxiety or depression (*3*). Continuity of care, encompassing timely detection, accurate diagnosis, evidence-based intervention, and comprehensive caregiver support, remains essential for mitigating this multifaceted burden (*4*).

Gaps in Continuity of Care

Despite significant advances in diagnostic criteria and therapeutic options, substantial gaps persist between scientific progress and real-world care delivery. Dementia remains widely underdiagnosed globally, with approximately 60% of cases going undetected and even lower diagnosis rates documented in underrepresented regions of China (*5*–*6*). The overall proportion of undetected dementia reaches 85.8% nationally, with rates of 77.5% in urban areas and 93.5% in rural areas (*7*). Furthermore, care-seeking behavior demonstrates considerable delays, with individuals typically waiting 2–3 years after symptom onset before pursuing medical evaluation (*8*). Low public awareness, persistent stigma, limited trained workforce capacity, and fragmented healthcare systems represent the primary drivers of this diagnostic gap.

While symptomatic medications remain available and affordable in China, more than 10% of diagnosed patients receive no treatment, and nearly 30% rely exclusively on lifestyle modifications (*9*). Non-pharmacological interventions (NPIs), though critical for maintaining functional capacity and quality of life, are inconsistently prescribed, inadequately funded, and rarely covered by reimbursement systems (*10*). This fundamental mismatch between patient needs and available services perpetuates significant inequities in healthcare access.

Meanwhile, routine cognitive screening remains substantially underutilized across healthcare settings. Although older adults generally value early detection opportunities, concerns regarding stigma and potential psychological distress reduce screening uptake (*11*–*13*). Integrating personalized health promotion strategies with ongoing support systems could effectively bridge this gap, particularly in the emerging era of disease-modifying therapies (*14*).

Policy Advances and Emerging Opportunities

The World Health Organization (WHO) officially adopted the Global Action Plan on the Public Health Response to Dementia (2017–2025) in May 2017, establishing seven key action areas. This WHO global

action plan provides implementation guidance for international, regional, and national decision-makers while setting ambitious global targets for 2025. National dementia action plans continue to expand worldwide, with increasing emphasis on early detection, prevention strategies, and improved care access. However, few countries have successfully implemented systematic brain health screening programs (*15*).

China has systematically integrated dementia into its national health priorities (*16*). The *Healthy China Initiative (2019–2030)* identified slowing dementia prevalence as a critical public health objective. On December 31, 2024, the National Health Commission, in collaboration with 14 ministries and central government bodies, launched the comprehensive *National Action Plan on Response to Dementia (2024–2030)*. This national dementia action plan establishes a robust framework aligned with the WHO Global Action Plan by highlighting seven main tasks (Table 1), setting eight anticipatory indicators, and designing nine specialized initiatives (referred to as "*zhuan lan*" or focused programs) (Table 1) (*17*). The plan emphasizes a "whole-of-society" approach, mobilizing healthcare, civil affairs, education, and media sectors to transform dementia from a private family burden into a shared public responsibility.

Key strategies within China's national action plan include: 1) Raising awareness through nationwide campaigns and comprehensive healthcare provider education. 2) Integrating screening and early intervention into primary care and community health services, supported by dedicated cognitive training centers. 3) Advancing multidisciplinary care through memory clinics, tiered referral systems, and coordinated hospital–community–home care pathways. 4) Supporting caregivers through psychological counseling, respite services, and structured training programs. These initiatives create opportunities to establish a comprehensive closed-loop system encompassing prevention, detection, intervention, and long-term management — ensuring more equitable and continuous care delivery. The key tasks align with these strategies and reflect a complete continuum of dementia care and prevention — from raising awareness (Task #1) and promoting positive attitudes toward dementia (Tasks #5 and #7), to implementing concrete action by improving access to dementia care services and driving innovation in care technology (Tasks #2, #3, #4, and #6).

Perspective: From Knowledge to Action

The theme of World Alzheimer's Month 2025, *"Ask About Dementia, Ask About Alzheimer's"*, emphasizes that knowledge serves as the foundation for meaningful change. However, awareness alone proves insufficient to transform lives. To translate knowledge into sustained impact, we propose the 3A approach — Awareness, Attitude, and Action — as a comprehensive framework for advancing continuity of care (*18–20*).

Awareness: Elevating public awareness and disseminating evidence-based knowledge about dementia represents a fundamental priority. Although most individuals recognize dementia symptoms, public understanding of when and where to seek professional support — and how to effectively support those living with dementia — remains critically inadequate (*18*). This health literacy gap extends beyond the general

TABLE 1. The main tasks and specialized initiatives ("*zhuan lan*") specified in China's National Action Plan on Response to Dementia (2024–2030).

Main task	Specialized initiative(s) ("*zhuan lan*")
#1. Disseminate knowledge of dementia care and prevention in public	# 1. Project on World Alzheimer's Month Theme Promotion
#2. Conduct dementia screening and early intervention	#2. Project on Capacity Building for Cognitive Function Screening and Early Intervention #3. Project on "Guarding Memory" Community Cognitive Training Activity Station
#3. Improve the service level of standardized diagnosis and treatment for dementia	#4. Project on Full-Course Dementia Service Collaboration Network #5. Project on Dementia Specialist Physician Training
#4. Increase the provision of care services for older adults with dementia	#6. Dementia Care Zone (Unit) Construction Project #7. Dementia Caregiver Training Project
#5. Build a dementia-friendly social environment	#8. "Yellow Bracelet" Dementia Elderly Care Campaign
#6. Strengthen technological support capabilities in response to dementia	#9. Dementia Information Management Project
#7. Strengthen international exchanges and cooperation on response to dementia	–

Note: "–" means not applicable.

population to encompass community healthcare providers and medical students, who will serve as frontline care providers for older adults (*19–20*). Strategic communication and comprehensive public education campaigns serve as essential tools for enhancing health literacy, dismantling stigma, and promoting early detection, diagnosis, and intervention. China's National Health Commission exemplifies this approach by leading nationwide awareness campaigns during global observances such as World Alzheimer's Month to strengthen public understanding of dementia.

Attitude: People living with dementia frequently encounter challenges with memory, recognition, and environmental comprehension that can result in behaviors others may perceive as disruptive or inappropriate. These manifestations often trigger negative attitudes toward both the individual and their family members. Furthermore, the pervasive misconception that dementia remains untreatable fosters therapeutic nihilism and persistent pessimism throughout existing care systems (*21*). Such attitudes perpetuate disadvantage and discrimination against affected individuals and families. Countering these harmful perspectives requires improving both the quality and accessibility of dementia services and care. Cultivating positive societal and professional attitudes becomes essential for fostering inclusive, person-centered care approaches. The integration of dementia into national public health agendas represents a promising advancement, reflecting governmental commitment to inclusivity and comprehensive care.

Action: Providing timely support to individuals with dementia and their caregivers remains a formidable challenge. Many families delay seeking diagnosis or appropriate care, and even when a diagnosis is established, post-diagnostic support is frequently inadequate, leaving individuals and families ill-equipped to navigate the necessary adjustments. Moreover, care systems typically operate in silos, with health, social, and community services functioning independently rather than collaboratively. While social prescribing has recently emerged as a promising approach to bridge medical and social care, as illustrated in Figure 1, the mechanisms for effective inter-sectoral collaboration remain underdeveloped and require substantial exploration to enhance both feasibility and operational efficiency (*22*).

Furthermore, significant regional disparities persist in both access to and utilization of dementia care resources across China, reflecting broader systemic inequities in service availability and quality (*23*). These disparities arise primarily from the uneven geographic distribution of trained specialists and specialized dementia care facilities nationwide. Implementing a comprehensive tiered referral system, coupled with multi-level training and supervision programs for primary care physicians and dementia specialists, will serve as critical enablers in establishing coordinated care across all healthcare system levels (Figure 2). To strengthen clinical management and disease control, there is an urgent imperative to translate existing policies and scientific advancements into accessible, equitable, and integrated services that seamlessly combine medical, social, and community support. The nine specialized initiatives outlined in China's national

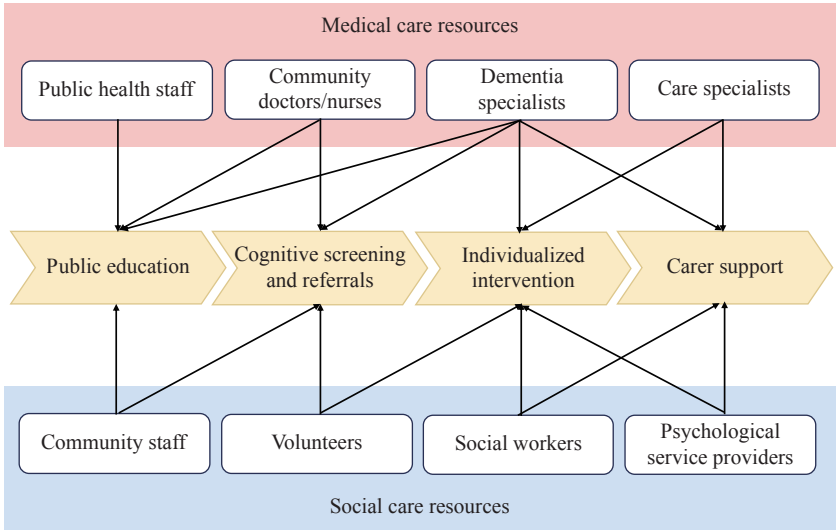

FIGURE 1. Inter-sectoral collaboration of the integrated dementia care system.

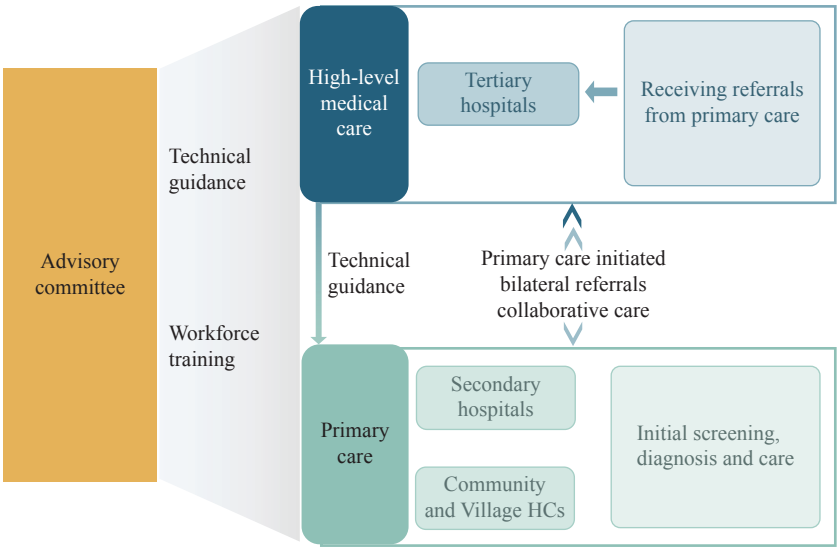

FIGURE 2. Coordinated care across different levels of healthcare institutions.

dementia action plan have established clear priorities for the next five years, targeting measurable improvements in dementia care and prevention — ultimately aiming to decelerate the rising prevalence of dementia nationwide.

CONCLUSION

Dementia care stands at a pivotal juncture. While advances in biomarkers, therapeutic interventions, and prevention strategies are fundamentally reshaping the clinical landscape, their transformative potential will remain unrealized without systematic implementation of care continuity. China's National Action Plan on Response to Dementia exemplifies how comprehensive, multisectoral strategies can effectively transform dementia from an isolated individual burden into a coordinated societal responsibility.

The central message of *World Alzheimer's Month 2025* — alongside China's national slogan, *"Prevent Early, Act Early, Protect Cognition"* — carries both immediate relevance and critical urgency. Through systematic integration of the 3A framework into clinical practice and public health initiatives, we can bridge the gap between awareness and transformative action, ultimately constructing a future where dementia is detected proactively, managed with evidence-based precision, and supported through compassionate, equitable care systems.

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Healthy China

National Survey on Nutrition Knowledge Assessment Among Junior High School Students — 31 PLADs, China, 2023–2024

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ABSTRACT

Introduction: Nutrition knowledge (NK) is a key modifiable factor influencing the dietary behavior and nutritional status of children. Currently, nationally representative data assessing NK among Chinese junior high school students are unavailable. This study aimed to assess NK levels using recent, nationally representative data from China.

Methods: A multistage stratified random cluster sampling method was used to select 28,629 junior high school students from 195 survey sites across 31 provincial-level administrative divisions in China. Data were collected using a standardized questionnaire developed using rigorous scientific procedures. NK awareness rates were described as weighted prevalence rates with 95% confidence intervals (*CI*s). Subgroup comparisons were performed using the Rao–Scott chi-square test.

Results: The overall NK awareness rate among Chinese junior high school students was 40.0% (95% *CI*: 36.5%–43.5%). The rates for the five dimensions, dietary recommendations, nutrient content of foods, food and health, food choices, and food safety, were 20.1%, 46.2%, 65.3%, 65.2%, and 65.2%, respectively. The analysis revealed significant variations in overall and dimension-specific awareness rates across groups. Boys, students from rural and western regions, and students from families with lower socioeconomic status had poorer NK levels than their counterparts. Among the 10 knowledge points with the lowest correct rates, seven belonged to dietary recommendations, two to food safety, and one to food and health.

Conclusion: NK awareness rates among junior high school students require improvement, especially regarding dietary recommendations, which remain a key component of students' nutrition education. Boys, students from rural and western regions, and students from families with lower socioeconomic status should be the key populations for NK dissemination in the future.

Nutrition knowledge (NK) is defined as an individual's cognitive process related to food and nutrition-related information, a key modifiable factor in dietary behavior and nutritional status in children (*1*). Improved NK is associated with healthier eating patterns, including increased fruit and vegetable consumption, and reduced childhood overweight/obesity risk (*2–3*). Junior high school students are at a crucial stage of physical and cognitive development when lifelong dietary habits form. Although they gain independence in food choices, most children fail to meet dietary guidelines and lack healthy dietary habits (*4*). This highlights the need to strengthen nutritional education and improve NK to promote healthy dietary habits and improve long-term health.

Given the importance of NK, *Healthy China 2030* aim to increase NK awareness by 10% from 2022 baseline levels by 2030 (*5*). However, baseline data on NK awareness among school-aged children are lacking. Previous studies were limited to regional populations and showed heterogeneity in populations, methods, and assessment tools (*6*). To address this gap, the China Nutrition and Health Knowledge Survey (CNHKS 2023–2024) was conducted in 2023 under the National Health Commission to assess NK in school-age children.

This study used data from junior high school students to assess NK levels and identify key target populations, priority regions, and core content areas for NK education.

METHODS

Data Source

The data were obtained from the CNHKS

2023–2024, a nationwide cross-sectional study using a multistage stratified random cluster sampling method to recruit children aged 6–17 years through schools from 195 survey sites (counties or districts) from 31 provincial-level administrative divisions in China. These sites were selected to ensure a nationally representative sample reflecting China's geographic and socioeconomic diversity. The sampling framework involved selecting two primary schools, one junior high school, and one high school per site. Stratified sampling by grade level was performed within each school, followed by random cluster sampling of classes. At each site, 504 children aged 6–17 years were selected per age group, maintaining sex balance. Participants should be able to communicate normally and without any serious intellectual disabilities. In total, 28,629 junior high school students participated. The inclusion criteria comprised students who completed data on all survey components, including basic information and NK. Students with missing demographic variables (sex and age; n=91) or missing NK scores (n=172) were excluded. This study included 28,366 students. All participants volunteered after understanding the survey content.

Data Collection

Data were collected using the Chinese Nutrition Health Knowledge Questionnaire for school-aged children (CNHKQ-C), developed by the National Project Team for CNHKS 2023–2024. This questionnaire assessed NK levels in Chinese children aged 6–17 years, following a rigorous scientific process (*7*). Delphi expert consultation and pilot testing demonstrated good reliability (Cronbach's α =0.79, split-half r=0.66) and validity (average scale-level content validity index =0.91, χ^2/df=2.87, root mean square error of approximation =0.048, goodness-of-fit index =0.92).

The CNHKQ-C had four versions for grades 1–3 of primary school, grades 4 and above, junior high school, and senior high school. The junior high school version contains 26 items across five NK dimensions: dietary recommendations (seven items), nutrient content of foods (four items), food and health (four items), food choices (seven items), and food safety (four items). NK scores ranged from 0 to 100 based on correct responses. Scoring included: single-choice questions (seven items at two points each, plus one item with three sub-items at two points each, totaling 20 points), multiple-choice questions (16 items with one point per correct option and four points maximum per question, totaling 64 points), table-based questions (one item containing eight sub-items at one point each, totaling eight points), and matching questions (one item with four matching pairs at two points each, totaling eight points). Incorrect answers were scored 0. Students scoring 75 points or higher were considered to have NK. The 75-point cutoff was determined without receiver operating characteristic curve analysis due to a lack of a gold standard binary outcome. Therefore, the cutoff score primarily referred to the established cutoff score for Chinese adults aged 18–64 years and those used in previous studies on children and adolescents (*8–10*). The overall NK awareness rate represents participants achieving this threshold. Dimension-specific NK awareness rate indicates participants scoring above 75% of the maximum possible score for that dimension. For the knowledge-point analysis, each single-choice question was considered one knowledge point, while multiple-choice, table-based, and matching questions' subitems or matching pairs were individual knowledge points. The questionnaire included 86 knowledge-based questions.

Sociodemographic information, including sex, grade, parental education, occupation, and home environment, was collected using a questionnaire. A composite socioeconomic status (SES) index was derived from these variables using factor analysis was categorized into low-, medium-, and high-level groups by tertiles.

Statistical Analysis

All analyses incorporated post-stratification weighting. NK awareness rate was expressed using the weighted rate with 95% confidence intervals (*CI*s). The Rao–Scott chi-square test compared differences in NK awareness rates between subgroups. Post hoc pairwise comparisons were conducted using Tukey's honest significant difference test. Multivariate logistic regression assessed subgroup differences after controlling for potential confounders, adjusting for sex, grade, SES, urban/rural area, and region. All analyses were conducted using SAS software (version 9.4; SAS Institute, Cary, NC, USA). Statistical significance was set at P<0.05.

RESULTS

The baseline characteristics of the participants are shown in Table 1. This study included 28,366 junior high school students, 14,214 males (50.1%), and 22,905 urban students (59.9%).

TABLE 1. Demographic variations in nutrition knowledge level among junior high school students (%, 95% *CI*).

Characteristics	Samples *N* (%)*	Total	Dietary recommendations	Nutrient content of foods	Food and health	Food choices	Food safety
Overall	28,366 (100.0)	40.0 (36.5, 43.5)	20.1 (17.9, 22.4)	46.2 (43.7, 48.7)	65.3 (62.8, 67.7)	65.2 (62.6, 67.7)	65.2 (62.9, 67.5)
Sex							
Male	14,214 (50.1)	38.2 (34.8, 41.7)	18.7 (16.4, 21.0)	45.9 (43.5, 48.4)	61.9 (59.2, 64.5)	62.8 (60.1, 65.5)	61.2 (58.6, 63.8)
Female	14,152 (49.9)	42.0 (38.4, 45.7)	21.6 (19.2, 23.9)	46.5 (43.8, 49.1)	69.2 (66.9, 71.6)	68.0 (65.5, 70.1)	69.9 (67.6, 72.2)
P		<0.001	<0.001	0.314	<0.001	<0.001	<0.001
Grade§							
7	9,793 (33.4)	34.4 (30.7, 38.1)	17.9 (15.4, 20.4) †	40.4 (37.3, 43.5)	61.6 (58.6, 64.5)	60.9 (58.0, 63.8)	61.6 (58.8, 64.4)
8	9,232 (33.6)	40.6 (36.6, 44.5)	19.9 (17.0, 22.8)†	46.8 (44.1, 49.6)	65.9 (63.2, 68.6)	66.7 (63.9, 69.5)†	66.6 (63.9, 69.4)†
9	9,341 (33.0)	45.1 (40.9, 49.4)	22.4 (19.5, 25.3)	51.4 (48.5, 54.3)	68.5 (65.7, 71.3)	68.1 (64.9, 71.2)†	67.5 (64.9, 70.1)†
P		<0.001	0.005	<0.001	<0.001	<0.001	<0.001
SES level§							
Low	13,136 (52.1)	33.2 (29.8, 36.5)	16.5 (14.0, 19.1)	40.2 (37.4, 43.0)	60.3 (57.1, 63.5)	60.5 (57.1, 63.9)	61.4 (58.2, 64.6)
Medium	6,547 (22.5)	41.4 (38.5, 44.2)	21.7 (19.2, 24.3)	47.0 (44.6, 49.3)	67.2 (65.1, 69.4)	66.6 (64.1, 69.1)	66.2 (63.9, 68.4)
High	8,683 (25.5)	52.8 (50.0, 55.6)	25.8 (23.2, 28.4)	57.7 (55.2, 60.1)	73.8 (71.8, 75.8)	73.6 (71.7, 75.6)	72.3 (70.3, 74.2)
P		<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Area type							
Urban	22,905 (59.9)	44.4 (41.3, 47.5)	21.4 (19.2, 23.7)	50.7 (48.5, 53.0)	68.7 (66.8, 70.6)	67.9 (66.0, 69.8)	67.7 (65.9, 69.6)
Rural	5,461 (40.1)	33.4 (26.6, 40.2)	18.0 (13.5, 22.5)	39.4 (35.1, 43.7)	60.2 (55.7, 64.8)	61.2 (56.0, 66.4)	61.5 (56.8, 66.2)
P		<0.001	0.185	<0.001	<0.001	0.009	0.008
Region							
Eastern	11,037 (37.0)	49.9 (44.0, 55.9)	27.5 (23.4, 31.5)	54.1 (50.2, 58.1)	69.9 (66.5, 73.2)	72.0 (68.6, 75.3)	69.5 (66.5, 72.6)
Central	8,503 (32.9)	37.1 (31.2, 43.1)†	16.8 (12.9, 20.7)†	43.1 (38.4, 47.7)†	62.9 (57.7, 68.0)†	64.8 (59.5, 70.1)	63.6 (58.7, 68.4)†
Western	8,826 (30.1)	30.9 (26.2, 35.7)†	14.5 (11.5, 17.5)†	39.8 (36.1, 43.5)†	62.3 (58.7, 65.8)†	57.4 (53.4, 61.4)	61.8 (57.9, 65.7)†
P		<0.001	<0.001	<0.001	0.010	<0.001	0.012

Abbreviation: SD=standard error; *CI*=confidence interval; SES=socioeconomic status.
* Percentages are weighted.
† Values sharing the same superscript letter do not differ significantly (*P*>0.05).
§ The Cochran-Armitage trend test showed *P*<0.05.

The overall NK awareness rate among junior high school students in 2023–2024 was 40.0% (95% *CI*: 36.5%–43.5%). Univariate analysis revealed significant variations among the demographic groups. Females (42.0%, 95% *CI*: 38.4%–45.7%) had a higher rate than males (38.2%, 95% *CI*: 34.8%–41.7%). The rate increased with grade and SES (P_{trend}<0.001). With regard to area type, students with a higher awareness rate were from urban areas (44.4%, 95% *CI*: 41.3%–47.5%) or eastern regions (49.9%, 95% *CI*: 44.0%–55.9%) (*P*<0.001), as visually summarized in Figure 1. Post-hoc analyses revealed no statistically significant differences between the central and western regions (*P*>0.05). Multivariate logistic regression analysis confirmed that the disparities across subgroups remained statistically significant after the adjustment (Table 2).

The highest awareness rates were 65.3% for food and health, 65.2% for food choices and food safety, 46.2% for the nutrient content of foods, and 20.1% for dietary recommendations. Subgroup differences in the awareness rates for each dimension matched the overall awareness rate. No significant sex differences were observed in the nutrient content (*P*=0.314), and no urban-rural differences in the dietary recommendation (*P*=0.185).

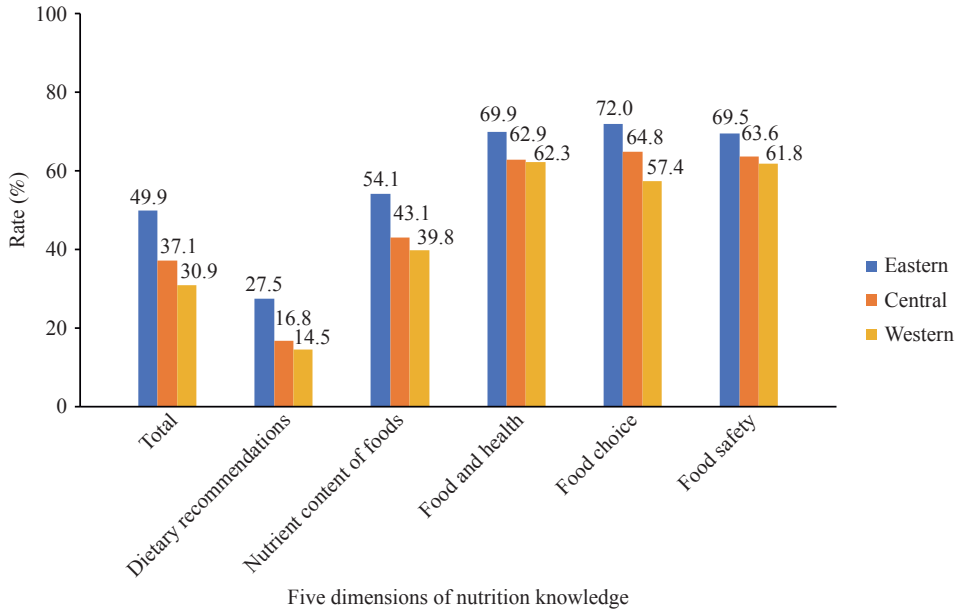

FIGURE 1. Regional differences in nutrition knowledge awareness rates.

TABLE 2. Univariate and multivariate analysis of disparities in nutrition knowledge level.

Variable	Unawareness (*N*=16,332)	Awareness (*N*=12,034)	Univariate analysis		Multivariate analysis	
			OR (95% *CI*)	*P*	*OR* (95% *CI*)	*P*
Sex						
Male	8,479	5,735	Reference		Reference	
Female	7,853	6,299	1.17 (1.12−1.23)	<0.001	1.19 (1.13−1.25)	<0.001
Grade						
7	6,172	3,621	Reference		Reference	
8	5,170	4,062	1.30 (1.19−1.43)	<0.001	1.33 (1.21−1.48)	<0.001
9	4,990	4,351	1.57 (1.37−1.80)	<0.001	1.57 (1.37−1.81)	<0.001
SES level						
Low	8,492	4,644	Reference		Reference	
Medium	3,784	2,763	1.42 (1.29−1.57)	<0.001	1.31 (1.19−1.44)	<0.001
High	4,056	4,627	2.25 (1.94−2.61)	<0.001	1.87 (1.63−2.13)	<0.001
Area type						
Urban	12,697	10,208	Reference		Reference	
Rural	3,635	1,826	0.63 (0.49−0.81)	<0.001	0.73 (0.59−0.91)	<0.001
Region						
Eastern	5,392	5,645	Reference		Reference	
Central	5,146	3,357	0.59 (0.44−0.80)	<0.001	0.68 (0.51−0.90)	<0.001
Western	5,794	3,032	0.45 (0.34−0.59)	<0.001	0.49 (0.38−0.63)	<0.001

Abbreviation: *OR*=odds ratio; *CI*=confidence interval.

Analysis of 86 individual knowledge points identified 10 with the lowest correct rates (18.4%–40.7%), shown in Table 3. "Shelf life and food safety" had the lowest correct rate (18.4%). Correct rates for the recommended daily intakes of cooking oil, salt, and added sugar were 22.9%, 33.8%, and 35.1%, respectively. Rates for the recommended intakes of soy products, dairy products, and meat were 33.3%, 38.3%, and 39.9%, respectively. Among these points, seven were from the dietary recommendations,

TABLE 3. Ten knowledge points with the lowest correct rates among junior high school students (ascending order).

Rank	Knowledge points	Correct rate (%)	Dimension
1	Shelf life and food safety	18.4	Food safety
2	Recommended level of daily cooking oil intake	22.9	Dietary recommendations
3	Recommended level of soy product intake	33.3	Dietary recommendations
4	Recommended level of daily salt intake	33.8	Dietary recommendations
5	Recommended level of daily sugar intake	35.1	Dietary recommendations
6	Keeping raw and cooked food separately during storage	38.1	Food safety
7	Recommended level of dairy product intake	38.3	Dietary recommendations
8	Lactic acid bacterial drinks are beverages, not dairy products	38.4	Food and health
9	Recommended level meat intake	39.9	Dietary recommendations
10	Nutritionally balanced breakfast combinations	40.7	Dietary recommendations

two from the food safety, and one from food and health. These points exhibited subgroup variations. Detailed comparisons are presented in the Supplementary Table S1 (available at https://weekly.chinacdc.cn/).

DISCUSSION

Our study provides a baseline assessment for *Healthy China 2030* by revealing a 40.0% NK awareness rate among Chinese junior high school students. This is lower than the rate reported for European adolescents (60%) (*11*) but higher than that of Italian adolescents (1.4%) (*12*). Although comparing CNHKS results with those of other studies is difficult due to different methodologies and evaluation criteria used, there remains room for improvement in the NK level of students in our country.

This study demonstrated significant variations in NK levels across demographic and socioeconomic groups, with higher rates observed among females, higher-grade students, and those from urban or eastern regions or with a higher SES. These results align with those of previous studies (*9*,*11*). Females show more interest in health and physical appearance than males. Students in higher grades better understand nutritional information through training and education (*9*,*11*). SES disparities in NK levels stem from three primary factors. First, parents with higher SES have greater NK, enabling better dietary guidance for their children (*13*). Second, they communicate nutritional information through daily interactions ("Drink milk to grow taller"). Third, knowledge transfers through observation of parental behaviors, including food choices. Children internalize knowledge by imitating their behavior (*14*). These create a favorable family food environment, fostering NK in children. Such SES-based disparities suggest NK dissemination should target parents and caregivers, particularly in disadvantaged families. Rural and Western students have lower NK awareness, possibly due to limited school-based nutrition education and community health resources (*15*). Therefore, more effort should focus on implementing targeted programs in these regions to address socioeconomic barriers and enhance intervention equity.

The current study revealed that junior high school students had limited knowledge of dietary recommendations, especially the Chinese Food Guide Pagoda, which presents intake levels of various foods graphically. Most students demonstrated limited awareness of the recommended intake of dairy, soy, and meat products. Monitoring data showed that actual consumption of these foods fell below the *Chinese Dietary Guidelines* 2022 standards, whereas oils and salt intake exceeded recommended limits (*4*). Furthermore, students' knowledge of the recommended daily salt, oil, and sugar intake remains insufficient. This suggests that despite the national "Three reductions" (reduced salt, oil, and sugar) initiative launched in 2016, awareness among students remains limited. These findings highlight the urgent need for school-based nutrition education centered on *Chinese Dietary Guidelines*. Beyond knowledge dissemination, nutrition education should focus on effective interventions to develop practical skills, including food selection, menu planning, and label reading. It should foster students' ability to translate NK into daily dietary practices, enabling healthy food choices while following dietary guidelines. This approach bridges the gap between knowledge and practical application, promoting healthy eating behaviors in the long term.

A key strength of this study is its use of nationally representative data, which provides a comprehensive overview of junior high school students' NK levels. Additionally, this study used a scientifically validated assessment tool developed through a rigorous, multistage process, ensuring the reliability of the NK evaluation. However, this study had certain limitations. First, although the sampling design ensured nationally representative coverage of mainstream junior high schools, it excluded students from special education or vocational schools. Second, despite adjusting for sociodemographic variables, unmeasured factors such as school nutrition education quality or socioeconomic development could result in residual confounding.

CONCLUSION

This study provides baseline data on NK awareness levels among junior high school students for assessing Healthy China 2030 indicators. It identified key target populations, priority regions, and core content areas for NK dissemination among Chinese junior high school students. The findings may guide policymakers, researchers, and public health professionals in developing targeted NK dissemination strategies. These include (*1*) expanding NK dissemination coverage, particularly in rural and low-SES areas, and (*2*) enhancing nutrition education by integrating evidence-based behavioral science and practical dietary skills into school curricula. Such approaches are essential for enhancing students' knowledge and skills, ultimately translating NK into sustained healthy eating behaviors.

Conflicts of interest: No conflict of interest.

Ethical statement: Approved by the Medical Ethical Review Committee of the National Institute for Nutrition and Health, Chinese Center for Disease Control and Prevention (No. 2022-037).

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Ten knowledge points with the lowest correct rates among junior high school students (listed in ascending order of correctness rate, Q1–Q10).

Characteristics	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Sex										
Male	21.1	23.1	31.4	32.9	34.5	40.4	37.2	36.3	38.5	39.8
Female	15.2	22.6	35.4	34.7	35.7	35.4	39.5	40.7	41.5	41.7
P	<0.001	0.362	<0.001	0.003	0.024	<0.001	<0.001	<0.001	<0.001	0.003
Grade										
7	19.2	22.8	33.0	32.1	35.6	38.8	40.3	37.2	43.1	38.0
8	18.3	22.8	32.6	32.2	34.6	38.5	36.7	36.3	37.0	40.0
9	17.7	23.0	34.3	37.0	35.0	37.0	37.9	41.7	39.6	44.1
P	0.099	0.980	0.486	0.003	0.733	0.258	0.054	<0.001	<0.001	<0.001
SES level										
Low	18.8	22.5	33.0	32.3	34.3	35.9	37.6	34.0	38.8	36.4
Medium	17.1	23.7	34.1	34.6	35.4	38.1	39.5	39.2	41.0	40.8
High	18.6	22.8	33.2	36.1	36.6	42.7	38.6	46.5	41.2	49.5
P	0.172	0.526	0.571	0.004	0.064	<0.001	0.303	<0.001	0.090	<0.001
Area type										
Urban	18.0	21.7	32.5	35.3	35.6	40.9	38.4	41.6	39.6	43.6
Rural	18.9	24.5	34.5	31.4	34.4	34.0	38.1	33.6	40.3	36.4
P	0.521	0.164	0.221	0.087	0.494	<0.001	0.897	<0.001	0.800	<0.001
Region										
Eastern	17.6	26.3	36.0	38.3	38.3	40.9	42.0	42.4	43.7	46.5
Central	16.9	19.2	31.8	28.4	33.3	35.5	36.3	36.2	37.5	41.2
Western	21.0	22.7	31.6	34.1	33.1	37.6	35.9	35.6	37.9	32.9
P	0.006	0.003	0.021	<0.001	0.005	0.012	0.020	<0.001	0.038	<0.001

Note: Q1: Shelf life and food safety; Q2: Recommended daily cooking oil intake; Q3: Recommended level of soy product intake l; Q4: Recommended level of daily salt intake; Q5: Recommended level of daily sugar intake; Q6: Keeping raw and cooked food separately during storage; Q7: Recommended level of dairy product intake; Q8: Lactic acid bacterial drinks are beverages, not dairy products; Q9: Recommended level of meat intake; Q10: Nutritionally balanced breakfast combinations.

Preplanned Studies

Curriculum Factors in Real-World Training Scenarios for Improving Intention of Laypersons to Perform Cardiopulmonary Resuscitation — Beijing Municipality, China, 2025

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Summary

What is already known about this topic?

Training laypersons can increase cardiopulmonary resuscitation (CPR) attempts by bystanders by improving their intention to perform CPR. However, the association between curriculum content and post-training intention to perform CPR remains unclear.

What is added by this report?

Key curriculum factors in CPR training can effectively improve laypersons' intention to perform CPR following training, and 74.7% of the laypersons enrolled in the training programs reported high CPR intention following training. In the low-intention laypersons, relative to the presence of zero to four factors, the coexistence of five to seven factors and eight or nine factors were associated with 174.7% [rate ratio (*RR*)=2.747; 95% confidence interval (*CI*): 0.964–7.826] and 283.6% (*RR*=3.836; 95% *CI*: 1.493–9.857) increase in high-intention incidence, respectively. A dose–response relationship was found in an indirect pathway in high-intention laypersons before training. However, the overall proportion of participants exposed to all nine curriculum factors was only 57.7%.

What are the implications for public health practice?

The translation of training into high post-course intention remains suboptimal in China. Identifying and improving curriculum factors linked to CPR intention would increase the prevalence of layperson interventions in China, especially factors that can increase trainees' self-efficacy in recognizing cardiac arrest and performing CPR correctly.

ABSTRACT

Introduction: This study aimed to investigate the associations between training curriculum factors and the intention of laypersons to perform cardiopulmonary resuscitation (CPR).

Methods: We recruited laypersons participating in CPR training programs from nine public training institutes in Beijing, China, between February 15 and July 15, 2025. The exposure variable in this cohort study was trainee feedback on course content, and the primary outcome was a high intention to perform CPR following training. Robust Poisson regression models were used to calculate the incidence rate ratios (*RR*s) with 95% confidence intervals (*CI*s).

Results: Among 2,035 laypersons enrolled, 74.7% reported high CPR intention following training. This proportion was 42.4% and 96.4% for those with low and high CPR intentions, respectively, before training. Nine curriculum factors with *RR*s greater than 1.000 were identified. In 817 low-intention laypersons, the coexistence of five to seven factors and eight or nine factors increased the likelihood of high intention by 174.7% (*RR*=2.747; 95% *CI*: 0.964–7.826) and 283.6% (*RR*=3.836; 95% *CI*: 1.493–9.857), respectively, compared with exposure to zero to four factors. In 1,218 high-intention laypersons, a dose-response relationship emerged indirectly, as curriculum factors enhanced CPR intention by improving self-efficacy in cardiac arrest recognition and CPR performance.

Conclusions: Our study highlighted that key CPR curriculum content is associated with the post-training intention to perform CPR in the real world.

Bystander-initiated cardiopulmonary resuscitation (CPR) is the most effective intervention for out-of-hospital cardiac arrest (OHCA). However, only 4.8% of patients in China receive it, contributing to over one million massive sudden deaths annually (*1*–*2*). The American Heart Association (AHA) Utstein Formula

for Survival states that public training is essential for translating scientific advancements into community-based lifesaving action (*3*). Standardized CPR courses provided by the Red Cross Society (RCS) and AHA are available to the public, and the average proportion of residents with first-aid certification in high-income countries is estimated at 10.2% (*4*). Within these frameworks, the effective transfer of knowledge and skills from the instructor to the trainee is regarded as a central driver in enhancing a layperson's intention to initiate CPR, as conceptualized in the AHA's intention-focused model (*5*–*6*).

However, no empirical studies have examined the relationship between the curriculum components of CPR training and laypersons' post-training intentions to perform CPR. This study aimed to explore the relationship between CPR curriculum factors and laypersons' intentions to perform CPR following real-world public training.

Between February 15 and July 15, 2025, we administered structured questionnaires to laypersons before and after the basic life support (BLS) training. The participating institutions included one emergency medicine center, two hospitals, and six social organizations that either voluntarily responded to the outreach efforts of the Chinese Center for Disease Control and Prevention (China CDC) or were recommended by the Beijing branch of the RCS. Participation in the survey was voluntary, and informed consent was obtained from each trainee prior to course initiation. The design of the questionnaire incorporated core content areas derived from standardized CPR curricula established by authoritative bodies, such as the RCS and AHA. To evaluate intention, respondents were asked to rate their willingness to perform CPR on a visual analog scale ranging from 0 ("not willing at all") to 10 ("definitely willing"). To assess self-efficacy, participants responded to the statements "I can identify OHCA correctly" and "I can perform CPR correctly" using a five-point Likert scale (strongly disagree, disagree, neutral, agree, and strongly agree). The exposure variable was defined based on participant feedback regarding specific elements of course content, such as "Instructors mentioned the *Civil Code of the People's Republic of China*" and "Instructors stated that chest–compression–only CPR is comparable to standard CPR that includes artificial respiration." The primary outcome was defined as a high intention to perform CPR following training, operationalized as a self-reported score of 9 or higher on a 10-point visual analog scale. Secondary outcomes included post-training self-reported strong agreement with the statements "I can identify OHCA correctly" and "I can perform CPR correctly," reflecting high self-efficacy in these domains.

The incidence rates of high intentions to perform CPR after BLS training were also calculated. To estimate the associations between curriculum factors and study outcomes, we employed robust Poisson regression models to calculate rate ratios (*RR*s) with 95% confidence intervals (*CI*s), adjusting for sex, age, public servant status, education level, previous CPR training experience, possession of a first-aid certificate, prior witnessing of an emergency, and high CPR intention before class. To account for the clustering effects associated with training institutions and instructors, the training class was modeled as a repeated-measures factor. The subgroup analysis were conducted based on the adjusted variables. All analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA). Statistical significance was defined as a two-sided P value of <0.05, except for tests of linear trends using the Chi-square method, in which a one-sided P value was applied.

A total of 2,035 participants from 148 training classes were analyzed. The sample comprised of a higher proportion of men, younger individuals, and those with college degrees or higher. The incidence of high CPR intention after training was 74.7%, whereas the rates were 42.4% and 96.4% for those with low and high intentions before training, respectively (Table 1). As shown in Table 2, the prevalence of the nine evaluated curriculum factors, each associated with an *RR* greater than 1.000, ranged from 79.7% to 96.4%. However, the proportion of participants exposed to all nine curriculum factors was only 57.7% (52.5% and 61.3% of those with low and high intentions, respectively), indicating a notable drop in comprehensive curriculum coverage. Each individual factor was associated with an increase in the incidence of reporting a high intention to perform CPR after training, which ranged from 6.3% to 15.0%. Compared with participants exposed to zero to four curriculum factors, those exposed to five to seven and eight to nine factors demonstrated a 15.6% increase (*RR*=1.156; 95% *CI*: 0.997–1.341) and 35.1% increase (*RR*=1.351; 95% *CI*: 1.174–1.555) in high intention rates, respectively, exhibiting a clear dose-response relationship (P for trend <0.001). This finding was consistent across the subgroups, except for CPR intention before training.

For all participants, in addition to the direct

TABLE 1. Incidence of high intention to perform CPR after training by population characteristics.

Population characteristics	*n* (%)	High intention to perform CPR (%)	*P*
Sex			
Male	1,117 (54.9)	74.8	0.863
Female	918 (45.1)	74.5	
Age (years)			
15–29	731 (35.9)	70.5	<0.001*
30–39	680 (33.4)	74.6	
40–49	435 (21.4)	79.1	
50–69	189 (9.3)	81.5	
Public servant status			
Yes	377 (18.5)	78.0	0.878
No	1,658 (81.5)	73.9	
Education level			
High school or less	96 (7.8)	76.0	<0.001*
College	791 (64.0)	75.0	
Graduate	349 (28.2)	65.3	
Enthusiastic philanthropist			
Yes	645 (31.7)	78.6	0.006
No	1,390 (68.3)	72.9	
Ever participated in CPR training			
Yes	745 (36.6)	75.7	0.425
No	1,290 (63.4)	74.1	
Ever witnessed CPR performed by others			
Yes	482 (23.7)	82.0	<0.001
No	1,553 (76.3)	72.4	
Intention to perform CPR before class			
Low	817 (40.2)	42.4	<0.001
High	1,218 (59.8)	96.4	
Total	2,035 (100.0)	74.7	

Abbreviation: CPR=cardiopulmonary resuscitation.
* *P* for trend.

relationship above, curriculum exposure was also associated with enhanced self-efficacy, particularly, the ability to recognize OHCA and correctly perform CPR, which further mediated CPR intention. For the 817 participants with a low CPR intention before training, relative to the presence of zero to four factors, the coexistence of five to seven factors and eight or nine factors was associated with 174.7% (*RR*=2.747; 95% *CI*: 0.964–7.826) and 283.6% (*RR*=3.836; 95% *CI*: 1.493–9.857) increase in high intention incidence, respectively. Participants exposed to five to seven and eight to nine factors were 137.8% (*RR*=2.378; 95% *CI*: 1.280–4.418) and 250.1% (*RR*=3.501; 95% *CI*: 1.868–6.558) more likely, respectively, to strongly agree with the statement "I can correctly perform CPR," than those exposed to zero to four factors. This showed a significant dose-response trend (*P* for trend <0.001). Furthermore, participants who agreed or strongly agreed with this statement were 73.0% (*RR*=1.730; 95% *CI*: 0.885–3.396) and 233.2% (*RR*=3.332; 95% *CI*: 1.674–6.632) more likely to report high CPR intention post-training, respectively (*P* for trend <0.001), than those responding "neutral" or lower. A similar pattern of association was observed for the intermediate variable "I can correctly identify cardiac arrest." For 1,218 with a high CPR intention before training, a similar dose-response pattern was also found in the indirect pathway, although the *RR*s were obviously small. Detailed information is shown in Figure 1.

TABLE 2. Association between curriculum factors and high intention to perform CPR following training.

Curriculum factors	Person number *n* (%)	High intention to perform CPR following training (%)		*RR*s (95% *CI*s)
		Yes	No	
Single curriculum factor				
Instructors mentioned the *Civil Code of the People's Republic of China*	1,779 (87.4)	75.6	68.8	1.074 (1.013, 1.139)
Instructors mentioned agonal breathing	1,951 (95.9)	75.1	64.3	1.084 (0.948, 1.239)
Instructors mentioned telecommunicator CPR	1,932 (94.9)	75.2	65.1	1.063 (0.940, 1.201)
Instructors stated that any CPR is better than no CPR	1,938 (95.2)	75.4	60.8	1.150 (1.031, 1.282)
Instructors emphasized immediate CPR when cardiac arrest is uncertain	1,680 (82.6)	76.9	64.5	1.116 (1.046, 1.190)
Instructors stated that chest-compression-only CPR is comparable to standard CPR that includes artificial respiration	1,639 (80.5)	77.3	63.9	1.140 (1.082, 1.202)
Instructors preset an emergency scenario	1,622 (79.7)	77.9	62.2	1.143 (1.073, 1.218)
Trainees practiced chest compressions at least once	1,962 (96.4)	75.0	65.8	1.137 (1.028, 1.258)
Trainees practiced use of an automated external defibrillator at least once	1,906 (93.7)	75.2	66.7	1.075 (0.966, 1.196)
Number of curriculum factors coexisting				
0–4	73	52.1	–	1.000
5–7	415	66.5	–	1.156 (0.997, 1.341)
8–9	1,547	78.0	–	1.351 (1.174, 1.555)
P for trend	–	<0.001	–	–

Note: Adjusted for sex, age, public servant status, education level, previous CPR training, possession of a first-aid certificate, prior witnessing of an emergency, high intention before training, and training class, if applicable;
–: not applicable.
Abbreviation: CPR=cardiopulmonary resuscitation; *CI*=confidence interval; *RR*=rate ratio.

DISCUSSION

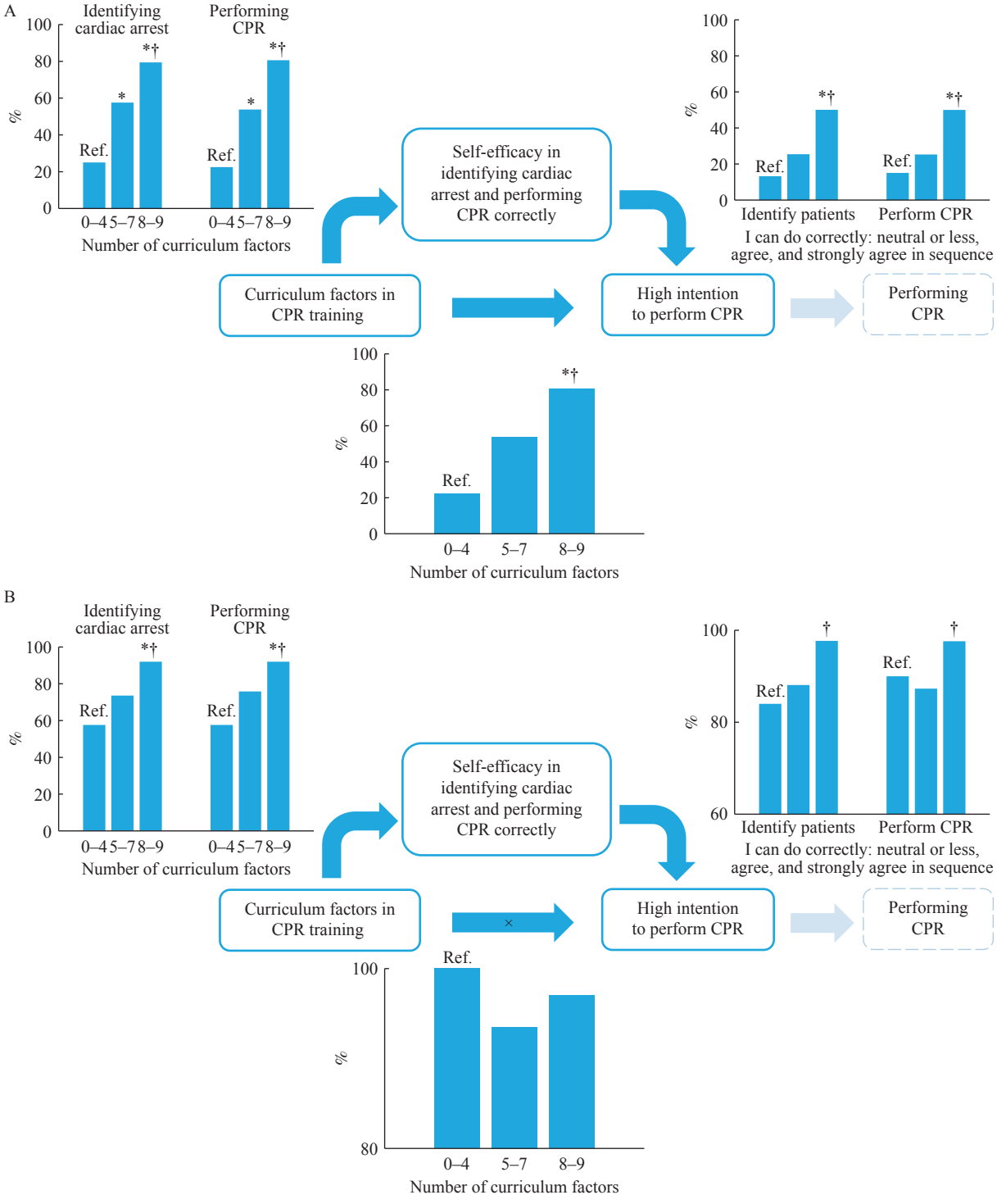
To our knowledge, this is the first study to systematically examine how specific CPR curriculum components influence laypersons' intention to perform CPR following real-world public training. This study demonstrated a clear association between key curriculum factors within CPR training programs and the post-training intention to perform CPR, although the overall translation of training into high post-course intention remains suboptimal in China.

These curriculum components either promote intention directly or increase self-efficacy in recognizing OHCA and correctly executing CPR, both of which serve as mediators of intention. This dual-pathway effect reinforces the theoretical foundations including the AHA a "Utstein formula for survival" and intention-focused model (*3*,*5*). Particular emphasis should be placed on the different association patterns between participants with low and high CPR intentions before training; the former revealed both pathways, whereas the latter being an indirect pathway. However, no single factor was universally effective for all participants. Even among the trainees exposed to all nine identified elements, a considerable proportion failed to report high intention following training.

Persistent barriers to bystander CPR in China, including unwillingness, lack of daring, and inability to save, continue to hinder timely emergency intervention (*7*). A critical limitation of current public training is the insufficient number of trainees reporting a strong intention to perform CPR following course completion. While structured training is a powerful and complementary strategy for addressing these barriers, current training primarily focuses on the "inability to save" issues related to CPR knowledge and skills, while neglecting the foremost "unwillingness to save." We have previously proposed specialized national CPR legislation as one solution for "unwillingness to save" (*8*). This study further contributes by defining concrete educational objectives and offering a structured approach for improving training effectiveness at the population level.

The *Healthy China* goal for 2022 of certifying more than 1% of residents in first-aid training has been achieved, with 15.26 million people obtaining certificates after BLS training since 2019 (*9*–*10*). CPR is a mandatory course for this certification, and has a

target to exceed 3% by 2030 (*9*). Health promotion policies were introduced to achieve this goal. For example, *Chinese Citizens' Health Literacy — Basic Knowledge and Skills (2024 Edition)* states that when encountering patients with OHCA, citizens should be able to perform CPR and use automated external defibrillators (*11*). Furthermore, the World First Aid Day publicity campaign was included in the 2025 annual work point of the *Healthy China Action Plan — Program for Cardiovascular and Cerebrovascular Disease Prevention and Treatment Campaign*. There is a significant gap between China and advanced countries in the prevalence of CPR training and bystander CPR, which reflects the quantity and quality of public training. Our previous study indicated that CPR promotion measures involve numerous industries,



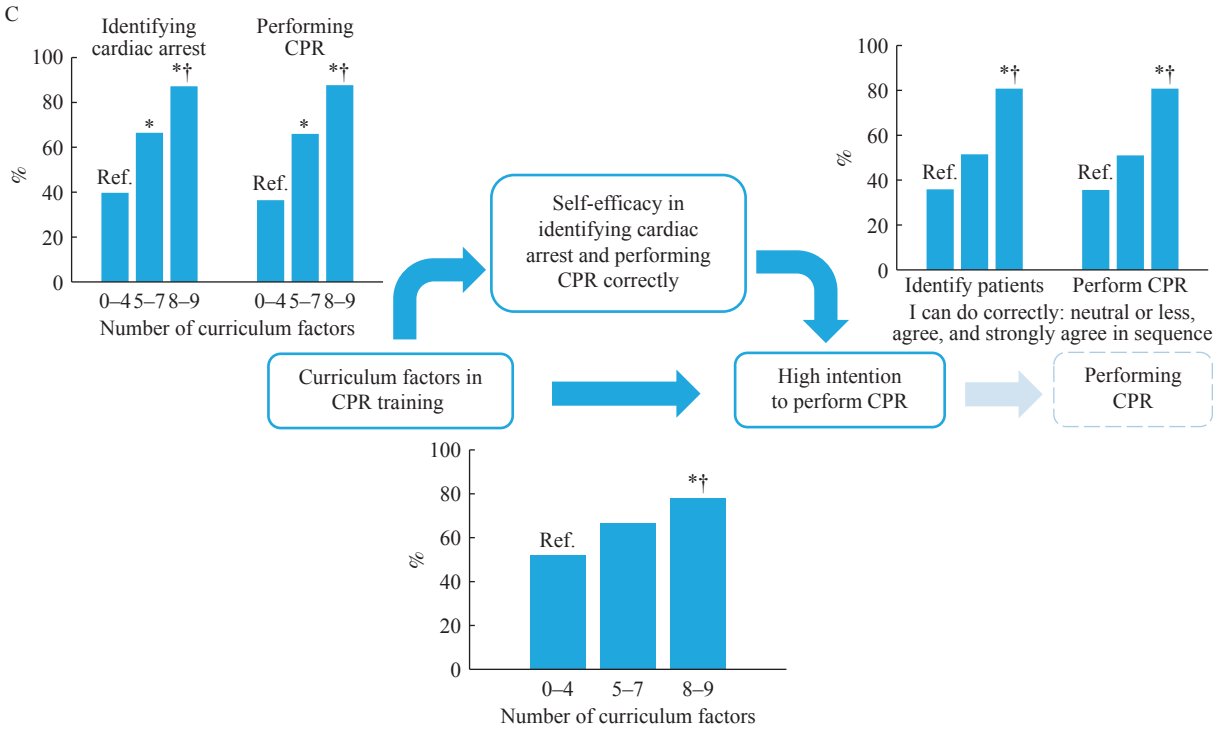


FIGURE 1. Dose-response relationships in the direct and indirect pathways linking curriculum factors in CPR training scenarios with laypersons' intention to perform CPR. (A) 814 participants with low CPR intention before training. (B) 1,218 participants with high CPR intention before training. (C) A total of 2,035 participants.
Note: Self-efficacy was assessed using the statements "I can correctly identify cardiac arrest" and "I can correctly perform CPR for patients with cardiac arrest." A strong agreement with either statement was considered indicative of high self-efficacy. In the left of Figure 1A, 1B, and 1C, "%" represents percent of participants post-training self-reporting strong agreement with the statements "I can identify OHCA correctly" and "I can perform CPR correctly." In the right and below of Figure 1A, 1B, and 1C, "%" represents percent of participants post-training self-reporting a high intention to perform CPR.
* *P* <0.05, compared with the reference.
† *P* for trend <0.001.
Abbreviation: CPR=cardiopulmonary resuscitation; OHCA=out-of-hospital cardiac arrest.

departments, and institutions (*12*); therefore, we suggest incorporating CPR education and training into the national education system of China through legislation, especially basic education and vocational training.

This study had at least two limitations. Our study is not community-based but possesses good institutional representativeness, covering all types of public CPR training institutions, including BLS courses delivered by the RCS, the AHA, and medical institutions. Additionally, this study is short-term, although it has a prospective component. We did not conduct follow-up assessments to capture actual bystander CPR behavior as per the potential bystander monitoring theory proposed by China CDC (*13*).

CONCLUSIONS

The association between curriculum content and post-training intention to perform CPR has been well established in the real world. Identifying and improving curriculum factors associated with CPR intention are recommended to increase the prevalence of layperson interventions in China.

Conflicts of interest: No conflicts of interest.

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Outbreak Reports

A Case Report of Dengue Infection After Allogeneic Hematopoietic Stem Cell Transplantation in Patient with Acute B-Lymphoblastic Leukemia — China, 2025

Ying Zhou[1]; Chaofeng Sun[1]; Qinglian Liu[1]; Yuanli Ling[1]; Bo Yang[1,#]

Summary

What is already known about this topic?

Dengue fever represents one of the most prevalent viral infections annually affecting the general population in endemic regions. It is widely recognized as an acute self-limiting disease, with the virus typically being completely cleared within 2–3 weeks post-infection, without establishing long-term latency. The current consensus is that primary infection with a specific serotype confers lifelong type-specific immunity, thereby preventing reinfection with an identical dengue virus serotype.

What is added by this report?

We report the case of a patient with leukemia who developed a confirmed dengue virus serotype 1 (DENV-1) infection during chemotherapy and targeted therapy. Notably, 6 months after the resolution of the initial infection, the same patient tested positive again for DENV-1 nucleic acid while undergoing intensive immunosuppression following allogeneic hematopoietic stem cell transplantation.

What are the implications for public health practice?

For patients undergoing hematopoietic stem cell transplantation and receiving immunosuppressive therapy, clinicians should be vigilant about the potential for persistent dengue infection, particularly in dengue-endemic regions. Furthermore, implementing prolonged serological monitoring post-infection is also crucial for the clinical management of this patient population.

ABSTRACT

Introduction: In 2025, a patient with leukemia in Haizhu District, Guangdong Province, China, tested positive for dengue virus. The local Center for Disease Control and Prevention immediately initiated an investigation and response.

Methods: This investigation included epidemiological surveys, vector mosquito surveillance, case findings, and blood sample collection for laboratory testing. The laboratory analyses comprised dengue virus nucleic acid detection, antigen detection, specific antibody detection, viral isolation, and genetic sequencing.

Results: The patient was diagnosed with dengue virus serotype 1 (DENV-1) infection 6 months prior to undergoing chemotherapy and targeted therapy for leukemia. Six months later, during high-intensity immunosuppressive therapy following allogeneic hematopoietic stem cell transplantation, the patient tested positive again for DENV-1. Genetic sequencing revealed 99.99% identity between the viral sequences obtained during initial infection and subsequent detection. Viral culture confirmed the presence of a replication-competent live virus.

Conclusions: This is the first documented case of persistent dengue virus infection lasting six months in a patient with leukemia in China. This highlights that for patients undergoing hematopoietic stem cell transplantation and immunosuppressive therapy, particularly in dengue-endemic regions, there should be heightened vigilance regarding the possibility of persistent dengue infection. Implementation of continuous serological monitoring is warranted in high-risk populations.

Dengue is primarily endemic to tropical and subtropical regions. The dengue virus (DENV) comprises four serotypes (DENV-1–4) and is predominantly transmitted through mosquito vectors (*1*). DENV is traditionally considered to cause only acute infection in humans, with efficient clearance by the host immune system post-infection. Reinfection typically occurs only upon exposure to different DENV serotypes. In immunocompetent individuals, dengue fever usually presents as an acute self-limiting disease. The viremic phase lasts approximately 2–7

days; the virus is typically cleared within 2–3 weeks post-infection, conferring lifelong homotypic immunity — mediated by DENV-specific memory T and B cells — which provides rapid protection against reinfection with the same serotype (*2*). Long-term dengue infections are rare. Herein, we report the first documented case of homologous DENV persistence following allogeneic hematopoietic stem cell transplantation (allo-HSCT), confirmed using whole-genome sequencing (WGS).

CASE REPORT

The patient was a 19-year-old male individual diagnosed with Philadelphia chromosome-positive acute B-lymphoblastic leukemia on August 3, 2024, presenting with fever, arthralgia, and severe thrombocytopenia (platelet count, 15×10^9/L). He subsequently received intensive chemotherapy combined with targeted therapy (hyper-CVAD regimen A plus orelabrutinib). On October 21, 2024, he developed fever, rash, and calf pain during chemotherapy. On day 5 of febrile illness, laboratory testing revealed positive dengue NS1 antigen with negative immunoglobulin (Ig)M and IgG antibodies and stable platelet counts. Reverse transcription polymerase chain reaction (RT-PCR) confirmed primary DENV-1 infection [cycle threshold (CT), 11.61]. Symptoms resolved within one week of supportive treatment. Chemotherapy was suspended for 2 months owing to persistent thrombocytopenia and reinitiated on January 17, 2025, with high-dose methotrexate, vincristine, prednisone, and orelabrutinib. No further dengue virus tests were performed during this interval.

On March 5, 2025, the patient underwent a myeloablative conditioning regimen consisting of total-body irradiation combined with fludarabine/cyclophosphamide, followed by paternal donor-derived allogeneic hematopoietic stem cell transplantation (allo-HSCT) on March 14, 2025. Neutrophil engraftment (absolute neutrophil count, $\geq0.5\times10^9$/L) and platelet engraftment (platelets, $\geq20\times10^9$/L) were achieved on post-transplantation days +11 and +12, respectively. On day +26 (April 9, 2025), a scattered pruritic erythematous rash (nonpainful) appeared on the palms and face, consistent with grade 3 acute cutaneous graft-versus-host disease (GVHD) by the National Institutes of Health (NIH) criteria. By day +30 (April 13, 2025), he developed unexplained diarrhea with abdominal pain progressing to hematochezia. Gastrointestinal endoscopy revealed diffuse mucosal erosion with hemorrhage. Concurrent refractory thrombocytopenia ($<20\times10^9$/L) persisted despite platelet transfusions. The patient received multiagent immunosuppressive therapy (methylprednisolone, cyclosporine, ruxolitinib) with suboptimal response, indicating therapy-refractory acute gastrointestinal GVHD. Biomarker profiling demonstrated high-risk features: sST2, 412,173 pg/mL; REG3 α , 10,416 pg/mL; sTNFR1, 3,108 pg/mL. The final diagnosis was concurrent grade 3 cutaneous and grade 4 gastrointestinal GVHD (NIH grading) complicated by refractory hematochezia and transfusion dependence.

The patient underwent screening for infectious sources owing to persistent diarrhea, hematochezia, and progressive thrombocytopenia with poor response to treatment. Plasma metagenomic next-generation sequencing detected the nucleic acid sequence of DENV-1 on May 20, 2025. Subsequent dynamic monitoring during May 16–29 demonstrated persistent positivity for viral RNA (CT, 19.51–20.56), positive NS1 antigen, positive IgM, and negative IgG. On June 4, 2025, WGS revealed a high degree of homology (>99.99%), with a single nucleotide difference of 10,635 nucleotides) between the DENV-1 sequence in this blood sample and the sequence obtained during the initial infection. Viable DENV was isolated from blood samples using *Aedes albopictus* C6/36 cell culture, with the isolate serotyped as DENV-1 by quantitative RT-PCR. The complete disease course and dengue testing timeline are shown in Figure 1.

Throughout nearly 1 month of isolation and treatment, the patient was continuously protected using a laminar airflow bed, effectively eliminating potential exposure to mosquito vectors. Surveillance data indicated no reported dengue cases (imported or local) in the patient's residential area within the 30 days preceding diagnosis. Mosquito surveillance data confirmed that the vector density within the patient's community remained below the safe threshold, meeting the national health authorities' criteria for no transmission risk (*3*). Furthermore, case-finding activities conducted among nearby residents and hospital facilities identified no suspected cases. The stem cell transplant donor (the patient's father) had no recent history of dengue infection. Written informed consent was obtained from the patient.

DISCUSSION

DENV is classically considered a non-persistent

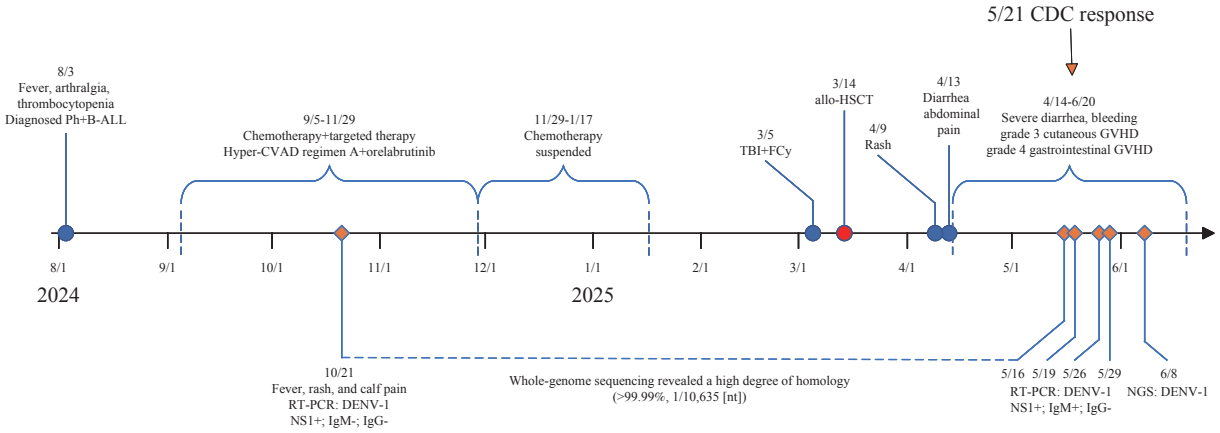

FIGURE 1. The complete disease course and dengue testing timeline of the case.
Note: "−" means negative; "+" means positive.
Abbreviation: B-ALL=B-lymphoblastic leukemia; allo-HSCT=allogeneic hematopoietic stem cell transplantation; GVHD=graft-versus-host disease; RT-PCR=reverse transcription polymerase chain reaction; NGS=next-generation sequencing; DENV=dengue virus.

pathogen in human hosts that typically causes self-limiting acute infections that are effectively cleared by the host immune response (*2*). The reinfection of individuals is believed to occur only through distinct serotypes. However, we report a rare case of a patient having leukemia with confirmed DENV-1 infection during chemotherapy who subsequently tested persistently positive for DENV-1 RNA 6 months after undergoing allo-HSCT and intensive immunosuppression therapy for graft rejection. This suggests that DENV infection may persist in immunocompromised or immunosuppressed populations with temporary immune impairment due to medical treatment or medication use, rather than repeated exogenous exposure.

Although dengue is primarily transmitted through mosquito vectors, cases of transfusion-related and organ transplantation-associated transmission have been documented (*4*). In the present case, we excluded cases of reinfection via mosquito vectors, blood transfusion, and bone marrow transplantation. Despite the occurrence of this case in Guangdong Province, China (a dengue-endemic region), the current epidemic pattern is driven primarily by imported cases without evidence of sustained local transmission chains (*5*). Surveillance data from the local Centers for Disease Control and Prevention indicated a Breteau Index of <5 (suggesting low mosquito density), and no locally acquired cases were reported for 3 consecutive months, thereby ruling out the possibility of community mosquito-borne transmission. Furthermore, the allo-HSCT donor showed no evidence of dengue infection. The likelihood of transmission related to allo-HSCT or blood transfusion is considered extremely low. Comparative genomic analysis of DENV-1 WGS during the initial infection and 6 months later revealed >99.99% sequence identity, confirming the occurrence of autologous persistent infection.

Persistent DENV infection remains exceptionally rare. In immunocompetent hosts, the canonical immunological response involves dengue-specific IgM seroconversion detectable 3–5 days post-infection (lasting 2–3 months), followed by IgG emergence around day 14, which confers lifelong serotype-specific immunity (*6*). Crucially, while pre-existing humoral immunity generally wanes after allo-HSCT, studies indicate that most patients with hematological malignancies retain high-titer measles/mumps/rubella IgG at 12 months post-transplantation (*7*). Notably, our patient remained dengue-IgG seronegative 6 months after the initial detection, suggesting failed protective antibody induction — potentially enabling viral persistence. Impaired immune surveillance in leukemia likely compromised both cellular and humoral antiviral clearance mechanisms (*8*). Collectively, such multifactorial immunosuppression provides the most parsimonious explanation for the observed DENV-1 detection at the 6-month follow-up.

In immunocompetent hosts, DENV infection activates T- and B-cell-mediated adaptive immunity, establishing lifelong serotype-specific immunological memory. Homologous reinfection triggers rapid memory responses (*6*). Paradoxically, impaired T/B-cell function disrupts viral clearance, memory formation, and immune activation. Literature documents viremia persisting ≤80 days post-HSCT in

patients with hematological malignancies (*9*). Ng et al. reported a 4-month DENV-3 RNAemia (non-cultivable) with concomitant 9-month infectious virus shedding in the urine of a renal transplant recipient (*10*). Thaivanich et al. detected DENV genomic RNA in granulocyte colony-stimulating factor-mobilized peripheral blood stem cells from an asymptomatic patient with myeloma in remission without recent symptoms or serological evidence (*11*). In this case, we observed a significant increase in GVHD biomarkers, which may be related to immunosuppression and DENV infection. Immune abnormalities in the patient could not effectively clear the DENV virus, thereby promoting persistent DENV infection.

Collectively, immunosuppressed hosts fail to achieve rapid viral clearance or establish sterilizing immunity, in stark contrast to immunocompetent individuals.

Because sustained virological monitoring was not performed post-initial infection, the exact viral state remains undefined. We recommend longitudinal monitoring of viral RNA, NS1 antigen, and serological profiles in immunocompromised patients (e.g., leukemia) post-dengue infection to elucidate persistence dynamics and clinical implications. Owing to the risk of infection, we recommend close virological follow-up after the acute phase, including weekly quantitative RT-PCR or NS1 testing within 4–6 weeks of symptom onset to track viral clearance, and prolonged monitoring of patients with low platelets, unknown causes, or signs of inflammation.

Clinically, dengue exhibits a significant symptomatic overlap with hematological disorders (*12*). Despite definitive laboratory evidence of acute dengue infection, the present patient lacked the classic dengue symptoms (fever, myalgia/arthralgia, and hepatic/renal impairment). The rash was attributed to acute GVHD, and diarrhea, hemorrhage, and thrombocytopenia were deemed disease-related. Given that immunocompromised patients may present with atypical manifestations and that active dengue infection can exacerbate underlying conditions, clinicians must include dengue in the differential diagnosis when managing hematological patients with unexplained clinical deterioration and implement comprehensive virological/serological assessments.

In summary, we documented persistent DENV-1 viremia over 6 months during chemotherapy and allogeneic HSCT in a patient with hematological malignancy. This underscores the need for vigilance against persistent dengue in immunosuppressed populations and highlights the critical role of sustained serological surveillance in clinical management.

Conflicts of interest: No conflicts of interest.

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Notifiable Infectious Diseases Reports

Reported Cases and Deaths of National Notifiable Infectious Diseases — China, July 2025*

Diseases	Cases	Deaths
Plague	0	0
Cholera	3	0
SARS-CoV	0	0
Acquired immune deficiency syndrome†	4,134	1,464
Hepatitis	136,194	283
Hepatitis A	1,635	0
Hepatitis B	113,578	39
Hepatitis C	17,538	243
Hepatitis D	20	0
Hepatitis E	2,837	1
Other hepatitis	586	0
Poliomyelitis	0	0
Human infection with H5N1 virus	0	0
Measles	135	0
Epidemic hemorrhagic fever	205	0
Rabies	27	21
Japanese encephalitis	3	0
Dengue	694	0
Anthrax	87	0
Dysentery	3,899	0
Tuberculosis	57,585	282
Typhoid fever and paratyphoid fever	672	0
Meningococcal meningitis	12	1
Pertussis	2,974	0
Diphtheria	0	0
Neonatal tetanus	3	1
Scarlet fever	4,268	0
Brucellosis	7,301	1
Gonorrhea	10,992	0
Syphilis	57,384	3
Leptospirosis	68	0
Schistosomiasis	2	0
Malaria	424	1
Human infection with H7N9 virus	0	0
COVID-19	226,567	2
Monkey pox§	135	0
Influenza	78,790	0

Continued

Diseases	Cases	Deaths
Mumps	6,907	0
Rubella	65	0
Acute hemorrhagic conjunctivitis	2,639	0
Leprosy	27	0
Typhus	164	0
Kala azar	31	1
Echinococcosis	412	0
Filariasis	0	0
Infectious diarrhea[¶]	148,551	0
Hand, foot and mouth disease	194,709	0
Total	946,063	2,060

* According to the National Bureau of Disease Control and Prevention.
† The number of deaths of Acquired immune deficiency syndrome (AIDS) is the number of all-cause deaths reported in the month by cumulative reported AIDS patients..
§ Since September 20, 2023, Monkey pox was included in the management of Class B infectious diseases.
¶ Infectious diarrhea excludes cholera, dysentery, typhoid fever and paratyphoid fever.
The number of cases and cause-specific deaths refer to data recorded in National Notifiable Disease Reporting System in China, which includes both clinically-diagnosed cases and laboratory-confirmed cases. Only reported cases of the 31 provincial-level administrative divisions in the Chinese mainland are included in the table, whereas data of Hong Kong Special Administrative Region, Macau Special Administrative Region, and Taiwan, China are not included. Monthly statistics are calculated without annual verification, which were usually conducted in February of the next year for de-duplication and verification of reported cases in annual statistics. Therefore, 12-month cases could not be added together directly to calculate the cumulative cases because the individual information might be verified via National Notifiable Disease Reporting System according to information verification or field investigations by local CDCs.

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