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ORIGINAL ARTICLE

Healthy lifestyles of contemporary Chinese population: challenges and new initiatives in primary cancer prevention

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Data sharing: All researchers in this study group welcome potential collaboration to maximize the use of data. A data dictionary and study protocol are available upon request by contacting the research group. Upon reasonable request, the datasets generated and analyzed during the current study are available, and the research group can provide descriptive data in table form. Requests can be made to Yawei Zhang (zhangya69@foxmail.com).

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ABSTRACT

Greater than 40% of cancer can be prevented through modifiable risk factors. The World Cancer Research Fund and American Institute for Cancer Research recommended healthy lifestyles for cancer prevention. No study, however, has investigated adoption rate of cancer prevention lifestyles in China. This article utilized data from a baseline survey of major cancer related risk factors in China including 89,045 participants. The results showed that the adoption rate of healthy lifestyles for cancer prevention among the contemporary Chinese population was 24.49%. Women (28.91%), individuals aged 40 years or older (26.43%-38.41%), had lower education level (27.60%), lived in rural areas (29.24%) and high or middle human development index regions (24.98%), and were unemployed (29.14%) had higher adoption rates. The adoption rate of healthy lifestyles was lowest among participants aged 25–29 years (14.16%) and showed an increased trend with age (P for trend < 0.001), with similar trends observed across subgroups stratified by sex, education level, residential area, and employment status (all P for trend < 0.001). Despite challenges in implementing primary cancer prevention, recent initiatives such as China Code Against Cancer and the Smart Health Management Digital Platform for Primary Cancer Prevention are expected to promote healthy lifestyles among the Chinese population, supported by national policies and international guidelines.

Key Words: preventive oncology, modifiable risk factors, lifestyle adoption, Smart Health Management, Code Against Cancer

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Introduction

Non-communicable diseases (NCDs), including cancer, become a significant public health challenge, hindering progress toward the Sustainable Development Goals. NCDs accounted for 75% of non-pandemic-related deaths worldwide in 2021, with the majority occurring in low- and middle-income countries[1]. Cancer is responsible for about 10 million deaths annually, second only to cardiovascular disease as the leading cause of NCD death globally[2] [1]. In China, there are 4.8 million new cases and 2.6 million deaths each year, accounting for approximately one-fourth of global cancer incidence and mortality respectively [2]. The cancer burden in China is expected to grow by about 50% in the next two decades,

[1] World Health Organization. Non communicable diseases. Accessed March 14, 2025. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases
[2] International Agency for Research on Cancer. Global Cancer Observatory. Accessed 16.02.2025. https://gco.iarc.fr/ Office of the Leading Group of the State

driven by the rapidly growing aging population, industrialization, and widespread unhealthy lifestyles [3]. Growing evidence indicates that more than 40% of cancers are preventable by addressing modifiable risk factors [4]. Recommendations from the World Health Organization suggest that reducing unhealthy behaviors is one of the most cost-effective ways to tackle NCDs including cancer [5, 6]. Aligning with the "Healthy China 2030" strategy, promoting healthy lifestyles and early intervention is crucial for reducing the cancer burden in China and worldwide.

Lifestyle risk factors, including unhealthy diet, alcohol consumption, physical inactivity, obesity, and tobacco use, contributed to more than 40% of global cancer deaths and disability-adjusted life-years [7], and China shared the same situation [8]. These individual lifestyle factors often co-exist and have synergistic effect on health [9]. World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) made recommendations on healthy lifestyles for cancer prevention, including being a healthy weight, being physically active, eating a diet rich in wholegrains, vegetables, fruits, and beans, limiting consumption of fast food and other processed foods, limiting consumption of red and processed meat, limiting consumption of sugar-sweetened drinks, and limiting alcohol consumption [10]. Multiple studies have provided supporting evidence that individuals who adhere to the 2018 WCRF/AICR recommendations experienced a reduced risk of breast, colorectal, and lung cancer, highlighting that promoting healthy lifestyles can serve as a primary cancer prevention strategy [11, 12].

Several studies from North America, Europe, and Africa reported on the prevalence of adherence to the 2018 WCRF/AICR recommendations and found wide variation between study populations, ranging from 6.28% to 40.1%, suggesting that there is considerable scope for promoting healthy lifestyles [11, 13–27]. No study has investigated compliance with the 2018 WCRF/AICR recommendations among Chinese populations.

This study analyzed data from an ongoing population-based study of major cancer related risk factors in China to understand the status of healthy lifestyles of the contemporary Chinese population follows the 2018 WCRF/AICR recommendations, identify challenges in promoting healthy lifestyles, and share new initiatives in promoting healthy lifestyles.

Methods

All data was from a baseline survey of major cancer-related risk factors in China between 07.07.2021 and 31.12.2024, including 148,338 participants. All participants were enrolled through the Smart Health Management Digital Platform for Primary Cancer Prevention (SmartHMDP-PCP) with an electronic module-based standardized questionnaire including information on demographic characteristics, lifestyle and environmental factors, medical history and medication use, and family history [28]. Majority of the study participants were from Beijing, Guangdong, Shaanxi, Henan, Gansu, Shanxi, and Sichuan provinces in China. Participants with missing data on variables in the 2018 WCRF/AICR recommendations (N=59,293) were excluded, yielding 89,045 participants being included for the final analysis. Electronic informed consents were obtained from all participants before investigation. This study was approved by the ethical committee of the National Cancer Center/Cancer Hospital, Chinese Academy of Medical Sciences.

The 2018 WCRF/AICR score was calculated by assigning the points of 1, 0.5, and 0 to fully, partially, and not meeting each of the recommended items, respectively. The 2018 WCRF/AICR score is represented in Supple-

ment A (supplementary materials on the journal website https://doi.org/10.47093/3034-4700.2025.2.1.38-52-annex-a). Physical activity was calculated as minutes per week through frequency and duration of moderate-vigorous leisure-time physical activity (e.g., yoga, walking, running, cycling, swimming), transport physical activity (e.g., walking briskly, running), household physical activity (e.g., child care, family care, yard work, scrubbing floors), and occupational physical activity. Total duration of moderate-vigorous physical activity was categorized into ≥150, 75-<150 and <75 mins/week. Dietary information was collected via a semi-quantitative food frequency questionnaire. The intake of fruits and vegetables was divided into three classes: ≥400, 200-<400, and <200 g/day. Total fiber intake was estimated from the frequency of consumption and portion size of food items using the Chinese standard tables of food consumption and subsequently categorized into ≥30, 15-<30, and <15 g/day [29, 30]. Alcohol consumption was based on daily ethanol intake of beer, grape wine, rice wine, and liquor. Sex-specific classification of daily ethanol intake was used in scoring alcohol consumption: fully (0 g/day), partially (>0-28 g/day for males and >0-14 g/day for females), and not meeting the recommendation (>28 g/day for males and >14 g/day for females). Red meat intake was categorized as <300, 300-500, and >500 g/week. Total sugar-sweetened drinks intake was categorized into <1, 1-2, and ≥3 can/day. The cutoffs of body mass index (BMI; underweight: <18.5, healthy weight: 18.5-<24, overweight: 24-<28, and obesity: ≥28.0 kg/m^2) were based on the criteria proposed by the Working Group on Obesity in China [31]. We used takeaways to replace fast food and was categorized into <1, 1-3, and ≥4 time/week. The final score was the sum of all points of seven items, with higher values indicating healthier lifestyle. The score was further categorized into unhealthy (0-4 points), moderately healthy (>4-<6 points), and healthy (6-7 points).

Characteristics of the study population were presented as numbers (percentages) for qualitative variables, and median (interquartile range) for quantitative variables, by the 2018 WCRF/AICR Score groups. Chi-square tests or Kruskal-Wallis tests were used to compare differences among the 2018 WCRF/AICR Score groups. The weights of the Segi's population and China's 2020 Census for calculating age-standardized prevalence rates (ASPR) of three lifestyle groups, respectively[3,4]. The linear trends of prevalence over age groups were tested using Cochran-Armitage test, both overall and by certain selected subgroups of individuals (e.g., sex, education, urban-rural location, employment status, geographic region, and regional human development index (HDI)). According to Human Development Report Office, regional HDI was divided into low (<0.550), medium (0.550-0.699), high (0.700-0.799), and very high (≥0.800)[5]. All statistical analyses were done with SAS version 9.4 and R version 4.3.2. Two-sided P value <0.05 was considered as statistical significance.

Results

Among 89,045 participants, the median (interquartile range) age was 38 (29-48) years and 57,384 (64.44%) were women. Of the overall population, 21,803 (24.49%) adopted healthy lifestyles, 54,279 (60.96%) adopted

[3] Office of the Leading Group of the State Council for the Seventh National Population Census. China Population Census Yearbook 2020. Beijing: China Statistic Press. 2022

[4] Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJ, Lozano R, Inoue M. Age standardization of rates: a new WHO standard. Geneva: World Health Organization; 2001. Accessed 16.02.2025. https://cdn.who.int/media/docs/default-source/gho-documents/global-health-estimates/gpe_discussion_paper_series_paper31_2001_age_standardization_rates.pdf

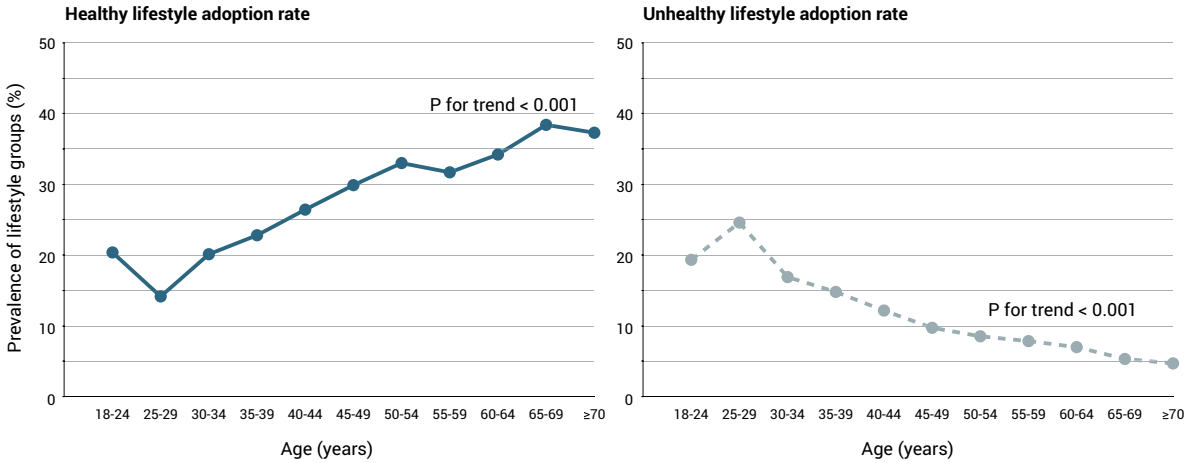
[5] United Nations Development Programme. Human Development Index (HDI). United Nations Development Programme. Accessed 16.02.2025. https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

Table. Characteristics of participants by the 2018 WCRF/AICR Lifestyle.
Abbreviations: WCRF/AICR, World Cancer Research Fund/ American Institute for Cancer Research; HDI, Human Development Index; ASPR, Age-standardized prevalence rate.

Characteristic	The 2018 WCRF/AICR Lifestyle										P-value
	Overall		Healthy (6-7 points)				Unhealthy (0-4 points)				
	N	Percent	N	Crude rate	ASPR (World)	ASPR (China)	N	Crude rate	ASPR (World)	ASPR (China)	
Overall	89,045		21,803	24.49%	26.08%	27.83%	12,963	14.56%	13.50%	12.01%	
Sex											<0.001
Women	57,384	64.44%	16,587	28.91%	31.39%	33.59%	6,330	11.03%	9.95%	8.53%	
Men	31,661	35.56%	5,216	16.47%	17.68%	19.25%	6,633	20.95%	20.26%	18.31%	
Education											<0.001
Below bachelor's degree	40,397	45.37%	11,150	27.60%	26.64%	28.40%	5,179	12.82%	13.89%	12.23%	
Bachelor's degree and above	48,556	54.53%	10,640	21.91%	25.88%	27.84%	7,770	16.00%	13.54%	12.19%	
Missing	92	0.10%	13				14				
Urban-rural location											<0.001
Rural	23,272	26.14%	6,805	29.24%	29.45%	30.81%	2,510	10.79%	10.59%	9.42%	
Urban	64,762	72.73%	14,756	22.78%	24.98%	26.85%	10,306	15.91%	14.50%	12.92%	
Missing	1,011	1.14%	242				147				
Employment status											<0.001
Unemployed	28,331	31.82%	8,257	29.14%	29.76%	31.26%	3,170	11.19%	10.71%	9.54%	
Employed	60,714	68.18%	13,546	22.31%	24.25%	26.38%	9,793	16.13%	15.68%	13.95%	
Geographic region											<0.001
South	14,858	16.69%	2,308	15.53%	18.29%	20.53%	3,175	21.37%	19.90%	17.86%	
North	74,178	83.30%	19,492	26.28%	27.65%	29.29%	9,787	13.19%	12.23%	10.85%	
Missing	9	0.01%	3				1				
Regional HDI											<0.001
Very high	10,839	12.17%	2,267	20.92%	20.94%	23.21%	1,872	17.27%	18.36%	15.89%	
Middle-to-high	78,203	87.82%	19,535	24.98%	26.86%	28.63%	11,091	14.18%	13.03%	11.61%	
Missing	3	0.00%	1				0				
Age group (years)											<0.001
18-24	13,384	15.03%	2,727	20.38%			2,589	19.34%			
25-29	9,982	11.21%	1,413	14.16%			2,456	24.60%			
30-34	13,570	15.24%	2,731	20.13%			2,293	16.90%			
35-39	12,812	14.39%	2,922	22.81%			1,896	14.80%			
40-44	11,146	12.52%	2,946	26.43%			1,357	12.17%			
45-49	9,751	10.95%	2,915	29.89%			949	9.73%			
50-54	9,013	10.12%	2,975	33.01%			769	8.53%			
55-59	4,953	5.56%	1,570	31.70%			389	7.85%			
60-64	2,101	2.36%	719	34.22%			147	7.00%			
65-69	1,333	1.50%	512	38.41%			71	5.33%			
≥70	1,000	1.12%	373	37.30%			47	4.70%			

moderately healthy lifestyles, and 12,963 (14.56%) adopted unhealthy lifestyles. The ASPR using the world standard population of healthy, moderately healthy, and unhealthy lifestyle were 26.08%, 60.42%, and 13.50%, respectively. The ASPR (world) of a healthy lifestyle was higher among women, individuals with education below a bachelor's degree,

Fig. 1. Age-specific adoption rates of healthy and unhealthy lifestyle in 2018 WCRF/AICR groups. Abbreviation: WCRF/AICR, World Cancer Research Fund/ American Institute for Cancer Research



those who were unemployed, and those residing in rural locations, northern regions, and regions with middle-to-high HDI (all P<0.001; Table).

The adoption rate of healthy lifestyles was lowest among participants aged 25–29 years (14.16%) and increased with age (P for trend < 0.001), peaking at the 65–69-year age group (38.41%), except for a slight decline observed in those aged 55–59 years (31.70%) (Fig. 1). Conversely, the adoption rate of unhealthy lifestyles followed the opposite pattern, showing a decreasing trend with age (P for trend < 0.001), with the highest level in the 25–29-year age group (24.60%) and declining to the lowest among those aged 70 years or older (4.70%). The similar lifestyle patterns were observed in subgroups stratified by sex, educational level, residential areas, and employment status (all P for trend < 0.001, Fig. 2). However, men consistently had lower adoption rates of healthy lifestyles and higher adoption rates of unhealthy lifestyles across all age groups as compared to women.

The age-specific adoption rates of healthy lifestyles were slightly higher among participants without a bachelor's degree than those with a bachelor's degree or above across the 25–29 to 65–69-year age groups. Compared with rural residents, urban participants had lower adoption rates of healthy lifestyles across all age groups except those aged 65 years or older, while the adoption rate of unhealthy lifestyles was higher among urban residents across all age groups. Among unemployed participants, the trend of healthy lifestyles almost mirrored that of the overall population, whereas among employed individuals, adoption rate increased from the 18-24-year (12.68%) to 50-54-year (32.01%) age groups before fluctuating in those aged 55 years or older, although the overall trend remained increasing. The adoption rate of unhealthy lifestyles was consistently higher among employed participants than unemployed individuals across all age groups.

Regional disparities were also observed. In northern China, the adoption rate of healthy lifestyles was higher, and that of unhealthy lifestyles was lower across all age groups except in the age group of 70 years or older. Stratification by regional HDI showed that participants living in very high HDI regions generally had lower adoption rates of healthy lifestyles, except in the 55–59-year age group. On the other hand, the adoption rate

Fig. 2. Age-specific adoption rates of healthy and unhealthy lifestyle in 2018 WCRF/AICR groups, among subgroups. Abbreviation: WCRF/AICR, World Cancer Research Fund/ American Institute for Cancer Research; HDI, Human Development Index.

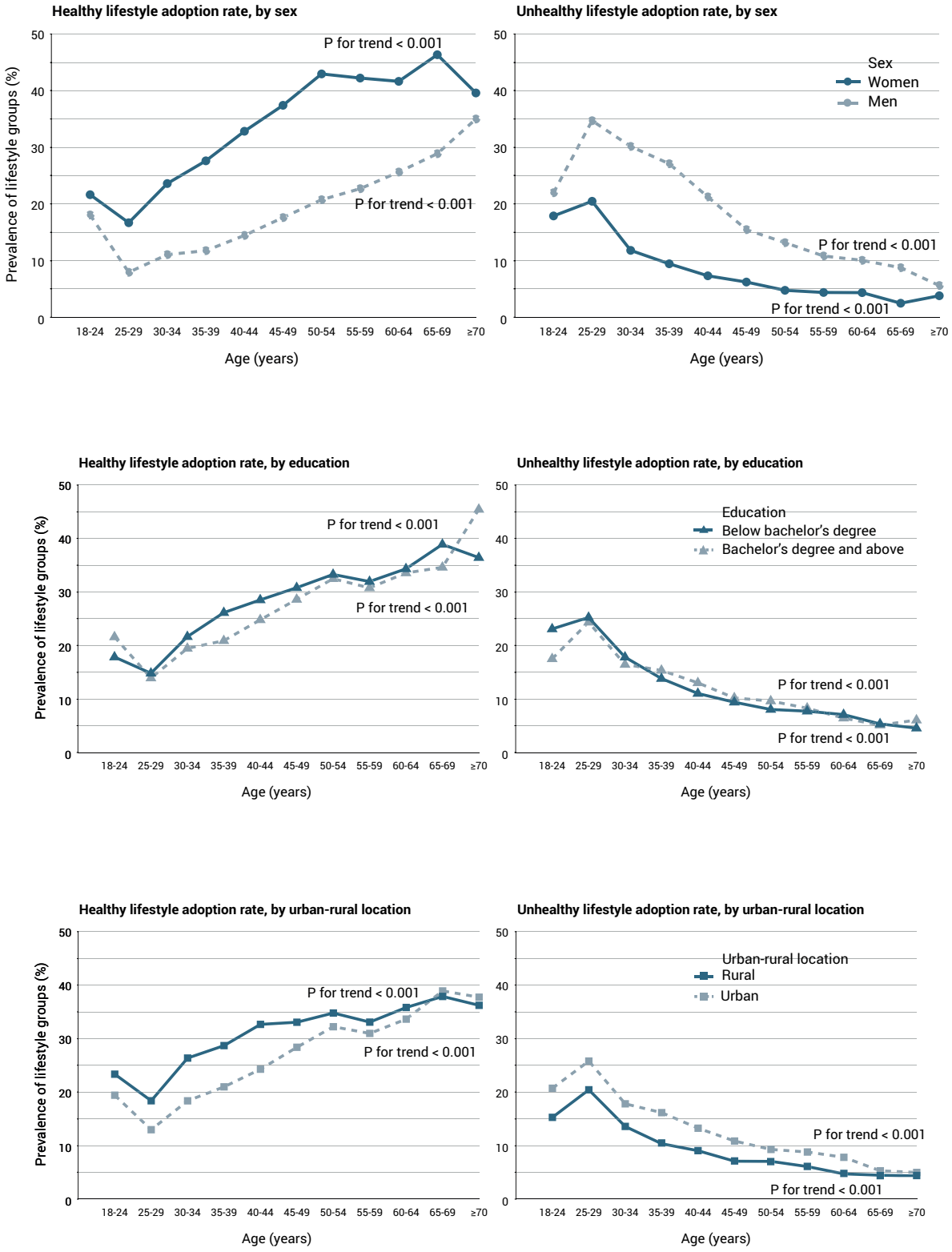


Fig. 2. Age-specific adoption rates of healthy and unhealthy lifestyle in 2018 WCRF/AICR groups, among subgroups. Abbreviation: WCRF/AICR, World Cancer Research Fund/ American Institute for Cancer Research; HDI, Human Development Index.

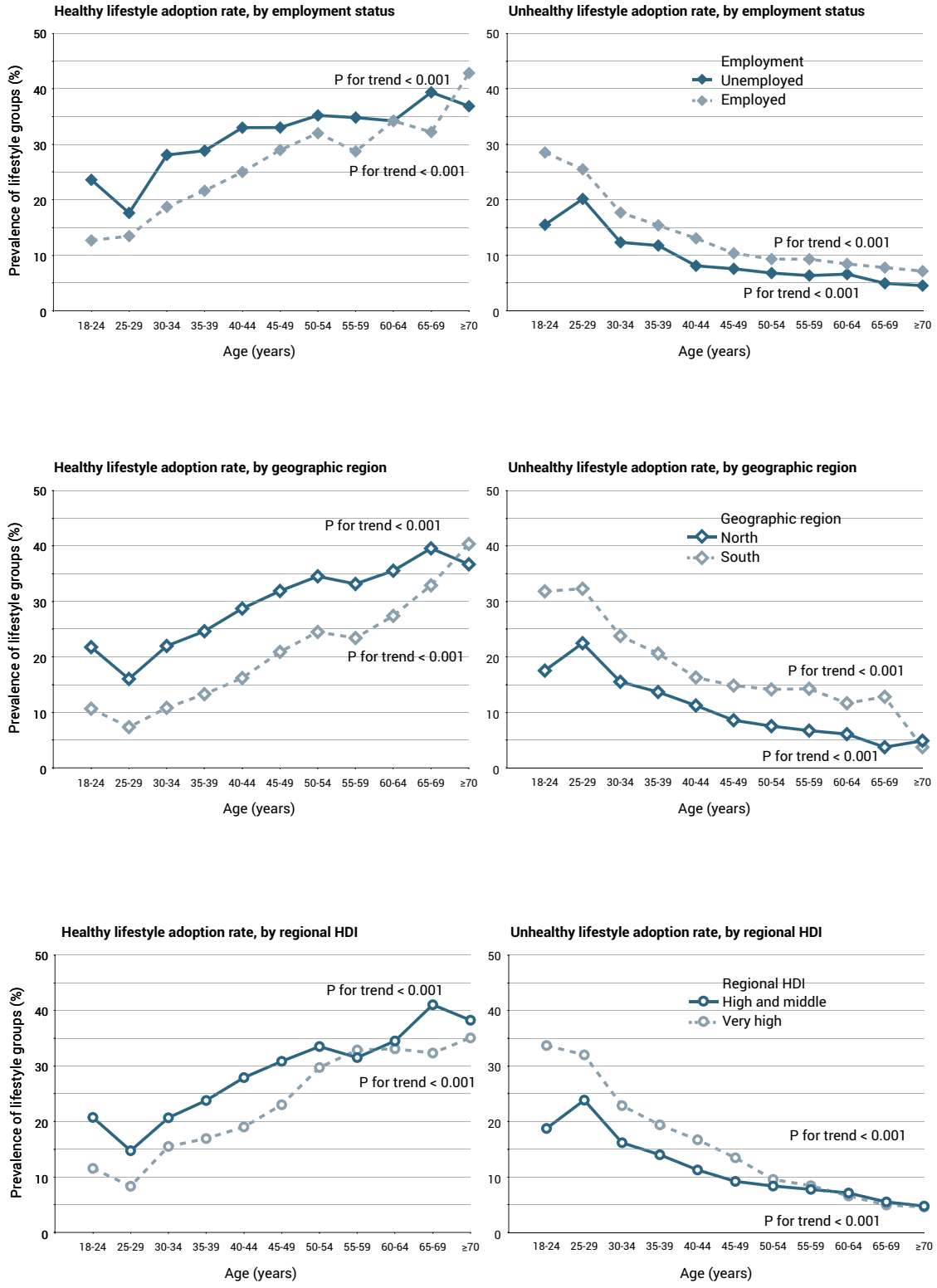
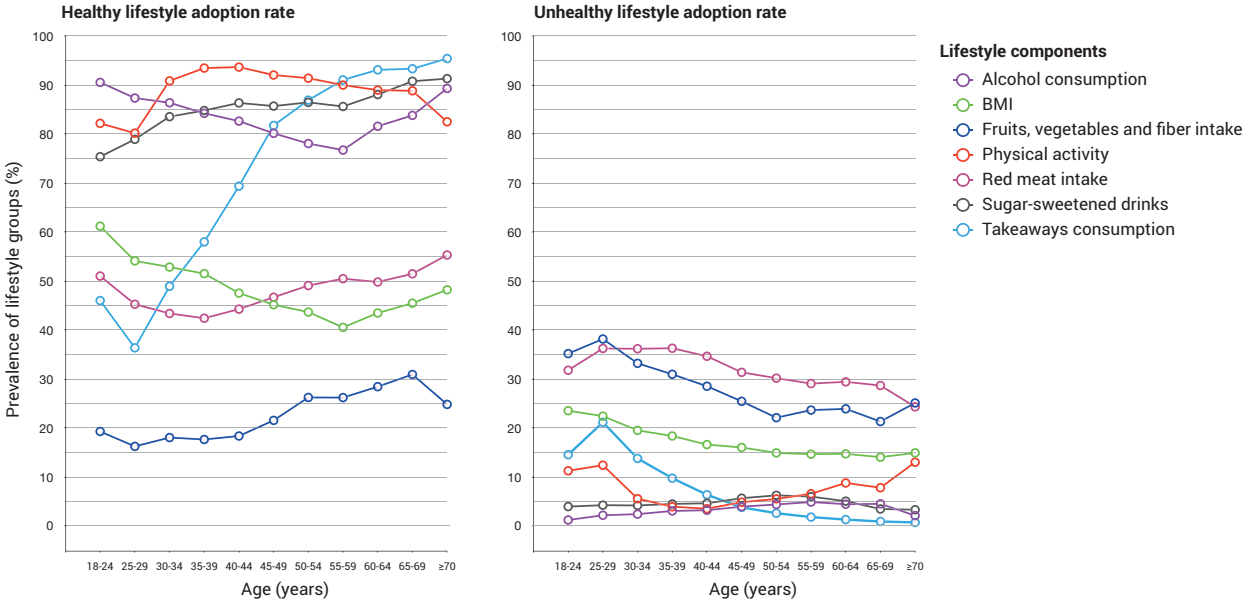


Fig. 3. Age-specific adoption rates of healthy and unhealthy lifestyle in 2018 WCRF/AICR components. Abbreviations: WCRF/AICR, World Cancer Research Fund/ American Institute for Cancer Research; BMI, Body Mass Index. For single lifestyles, healthy lifestyle represented "1 point" for the correspondent recommendation, and unhealthy lifestyle represented "0 points". All P for trend were <0.001 in all groups.



of unhealthy lifestyles was higher in very high HDI regions for all age groups before 60–64 years.

We further analyzed single lifestyle components, and found that adherence to recommendations regarding fruit, vegetable, and fiber intake was the lowest across all age groups (all age-specific prevalences <40%; Fig. 3). Similarly, adherence to BMI recommendations and red meat intake guidelines was relatively low. In contrast, adherence to physical activity, sugar-sweetened drinks intake, and alcohol consumption guidelines was relatively higher. Older participants demonstrated greater adherence to recommendations for takeaway food consumption, sugar-sweetened drinks intake, red meat intake, and fruit, vegetable, and fiber intake. Among them, adherence to recommendations on takeaway food consumption showed substantial changes with age, with a marked increase starting from the 25–29 years (36.35%) to 70 years or older (95.40%) age group. Conversely, the age-specific adoption rate of unhealthy adherence followed the opposite trend.

Discussion

Status of healthy lifestyles of contemporary Chinese population

To the best of our knowledge, this represents the first study to report the prevalence of combined lifestyles in adherence to the 2018 WCRF/AICR recommendations in a Chinese population. This study found that approximately a quarter of the people had healthy lifestyles. In general, women, older individuals, people lived in rural areas, and people lived in middle-to-high HDI regions were more likely to adopt healthy lifestyles. While compliance with the 2018 WCRF/AICR recommendations in this study was comparable to other studies, the fact that only about one fourth

of the overall population and less than one fifth of young people adopted healthy lifestyles suggests that more efforts are needed to increasing adoption rates.

According to a national health literacy monitoring survey in 2021 in China, individuals with higher educational levels possessed greater health literacy than those with lower educational levels [32]. However, our study did not observe a higher prevalence of healthy lifestyles among people with greater education levels. In developing counties like China, development of health-supportive system might lag behind rapid social and economic transformations, causing the health penalty to high social economic status individuals [33]. On the other hand, unhealthy dietary and drinking options were less affordable and often perceived as privileges of the advantaged individuals. Other potential explanations may be due to lack of effective health education regarding primary cancer prevention. More efforts are needed to explore potential barriers to people adopting healthy lifestyles. Notably, the government launched the "Weight Management Year" initiative, aiming to promote healthy lifestyles, with a particular focus on a healthy lifestyle friendly environment[6].

In China, 920 million people lived in urban areas and 733 million were employed[7]. These employed and lived in very high HDI regions and in urban areas often have greater financial power to afford unhealthy behaviors. Meanwhile, the fast-paced life, high work demand, extended working hours, job insecurity, and commuting difficulties made it difficult for people to adopt a healthy lifestyle [34]. In our study men had significant lower rate of adopting healthy lifestyles compared to women, indicating that sex imbalance in social role might adversely affect men's engagement in healthy lifestyles in China. Therefore, in addition to promoting health literacy, building a more supportive working and living environment is also essential in facilitating healthy lifestyle, such as creating healthy canteens, corporate gyms, and discouraging alcohol-based socializing.

All study participants were smartphone users who completed online surveys, the findings may not be generalizable to non-smartphone users in China, especially older adults. We reported age-standardized rates to address the concerns that majority of our study population were under 60 years old. In this study, takeaways, which included healthy and unhealthy options, were used to replace ultra-processed food, might introducing potential misclassification. Although the relationship between 2018 WCRF/AICR recommendations and cancer risk among Chinese population remains to be explored, targeted strategies should be implemented to increase the rate of healthy lifestyle in adherence to the 2018 WCRF/AICR recommendations to reduce the cancer burden in China, which accounted for about one fourth of the world's newly diagnosed cancer cases in 2022 [2].

Challenges in primary cancer prevention in China

The observed low prevalence of healthy lifestyles related to cancer prevention among the Chinese population suggests existing challenges in primary cancer prevention. Lack of health knowledge and awareness, as well as health misinformation and disinformation are the most significant barriers to making informed healthy lifestyle choices. Despite increasing access to information, health education and health literacy re-

[6] The National Health Commission of the People's Republic of China. Notice on the Implementation Plan for the "Weight Management Year" Activity. (in Chinese). Accessed 16.02.2025. http://www.nhc.gov.cn/ylyjs/pqt/202406/b4f7141179504bd69d7a18db6d877f47.shtml

[7] Chinese National Bureau of Statistics. China Statistical Yearbook 2023. Beijing: China Statistics Press; 2023. Accessed 16.02.2025. https://www.stats.gov.cn/sj/ndsj/2023/indexeh.htm

main limited in many communities, making it difficult for these populations to make informed decisions about their health. On the other hand, rising social media usage, combined with anxiety and fear of cancer among the general population, has fueled the spread of a range of misleading claims about cancer prevention, which can probably lead people to disregard evidence-based preventive behaviors in favor of lifestyles endorsed by influencers, downplay the importance of mental health issues, and promote unregulated supplements [35]. Therefore, there is an urgent need to establish an authoritative evidence-based information dissemination platform for cancer risk factors and preventive intervention measures to convey the facts in a way that leaves no room for misunderstanding and to enhance the correct understanding of healthy lifestyles for cancer prevention among the Chinese population. Since barriers to adopting a healthy lifestyle may vary depending on personal characteristics, sociocultural background, and environmental factors, the dissemination of healthy lifestyle information should also be tailored to each individual [36].

Lack of motivation is another major challenge to adopting and sticking to healthy lifestyles. Many people feel overwhelmed by the thought of starting healthy behaviors, especially those who have failed in past attempts to change and stick with such behaviors. This frustration can lead to procrastination and avoidance, making it more difficult to take the first step toward a healthier lifestyle. In addition, motivation may wane over time, particularly if the immediate effects on health are not evident. Therefore, when promoting healthy lifestyles to the general population, appropriate theoretical models should be applied to attract those unmotivated people who are difficult to reach with traditional health promotion activities, cultivate their motivation for action, and increase their acceptance and persistence of healthy behaviors [37].

The Chinese population is diverse in terms of ethnicity, cultural background, geographic region, and socioeconomic status. These diversities are not only related to whether individuals actively choose a healthy lifestyle, but also to the objective accessibility of a healthy lifestyle. Mobile technology plays an increasingly important role in promoting healthy lifestyles as its low cost and multifunctionality make health resources more affordable and distributed more equitably. Mobile health (mHealth) provides easy access to information on diet and nutrition, guidance and assistance for training and exercise, and tracking and monitoring physical activity, food consumption, sleep, and phycological measurements (e.g., heart rate, blood pressure, and blood sugar), so wider use of mHealth should be encouraged to assist health promotion efforts [36].

New initiatives in primary cancer prevention in China

In 2016, China released the “Healthy China 2030” national strategic plan, which identified national health as a development priority and reflected China’s commitment to participating in global Health governance and implementing the United Nations 2030 Agenda for Sustainable Development[8] [38]. Under the framework of the “Healthy China Action Plan 2019-2030”, the State Council of China issued two versions of the Healthy China Action – Cancer Prevention and Control Implementation Plan in 2019 and 2023, respectively. These national strategies emphasized reducing exposure to cancer risk factors to prevent cancer. In line with the national policies and promoting healthy lifestyles for primary can-

[8] United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. Accessed 17.02.2025. https://sdgs.un.org/2030agenda

cer prevention, the National Cancer Center of China (NCC China) developed China Code Against Cancer (CCAC) and the SmartHMDP-PCP.

China Code Against Cancer

To inform the general public about evidence-based behaviors that can be taken to reduce cancer risk, NCC China published the CCAC 2025 version and established the CCAC official website (https://ccacdcpc.org.cn/) as an authoritative communication platform for cancer-related health information. The CCAC was drafted under the general framework of the World Code Against Cancer Framework proposed by the International Agency for Research on Cancer, which was aimed to encourage countries and regions to develop regional codes against cancer according to their local characteristics [39].

The CCAC 2025 version includes 15 action-based recommendations to guide the public to adopt healthy lifestyles, avoid or reduce exposure to carcinogenic agents, and participate in vaccinations, aiming to reduce an individual's risk of developing or dying from cancer. The CCAC is presented in Supplement B (supplementary materials on the journal website https://doi.org/10.47093/3034-4700.2025.2.1.38-52-annex-b). All the recommendations were developed in accordance with the following principles: 1) based on strong scientific evidence, balancing risks and benefits, and posing no additional risks to individuals when implemented; 2) broadly applicable to the general Chinese population without requiring any prerequisites or expertise; 3) taking into account the spectrum of cancer burden in China, the cultural practices of different populations, and the distribution of healthcare services; and 4) able to be clearly and concisely communicated in simple, instructive language that is easy for the public to understand and follow.

Smart Health Management Digital Platform for Primary Cancer Prevention

The NCC China has also developed a smartphone health applet, the SmartHMDP-PCP, to address the challenge of lacking an effective mechanism to attract people to actively adopt and adhere to a healthy lifestyle. The SmartHMDP-PCP can serve as an innovative solution to provide a cost-effective approach for personalized cancer prevention interventions and offer sustainable incentives for the public to engage in healthy lifestyles.

The SmartHMDP-PCP is powered by mobile technology, data science, and personalized intervention strategies. It runs in the WeChat environment. People can use the applet to 1) assess their risk of developing 19 types of cancer, including the cancers of the brain, head and neck, thyroid, lung, esophagus, stomach, liver, pancreas, colorectum, kidney, bladder, female breast, ovaries, endometrium, cervix, and prostate, as well as leukemia, Hodgkin lymphoma, and non-Hodgkin lymphoma; 2) track and archive their long-term exposure to behavioral, environmental, social, psychological, medical, and metabolic factors; and 3) obtain personalized intervention strategies for healthy lifestyles to reduce their cancer risk.

The SmartHMDP-PCP has multiple advantages in healthy lifestyle assistance and primary cancer prevention. This applet is based on smart mobile devices and commonly used social software, so it can be easily accessed and used in daily life. Given the continued development of mobile technology and the increasing number of mobile technology users, the impact of such mHealth interventions is likely to expand further. In addition, the highly cost-effective nature of mHealth interventions enables them to be widely disseminated to different socioeconomic groups with-

out geographical restrictions, which can to some extent reduce potential inequalities in the distribution and access to health resources among large and diverse populations. Real-time assessment and early warning of future cancer risks, as well as interactive systems for reporting cancer-related exposures and targeted preventive interventions, can potentially improve user engagement and compliance. The personalized health education and cancer prevention interventions provided by SmartHMDP-PCP achieved two-stage behavior changes by promoting health cognition and reducing action barriers, respectively. There is evidence that health interventions based on both cognitive and proactive phases of behavior change are more effective than interventions based on either phase alone [40]. In addition, personalized health information and intervention strategies are more likely to increase individual engagement and trigger central persuasion pathways, leading to a stable motivational effect during application [40]. The SmartHMDP-PCP also used the health belief model and protection motivation theory to further enhance the effect of behavior change. The cancer risk early warning system can serve as a threat trigger to motivate individuals to take actions to promote health and prevent cancer. The engagement and retention of SmartHMDP-PCP users are also key factors in achieving a long-term and sustainable healthy lifestyle, as significant health effects require a certain level intensity and persistence of intervention.

In conclusion, there are variations of healthy lifestyles adoption rates among the contemporary Chinese population. CCAC provides an authoritative platform for disseminating evidence-based information, and SmartHMDP-PCP provides novel approaches for individualized primary cancer prevention, putting national policies into practice. Further implementation and continuous evaluation and updating are necessary to achieve optimistic adoption rates of healthy lifestyles.

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