Dietary and other lifestyle factors and their influence on non-communicable diseases in the Western Pacific region

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Summary

The Western Pacific region is a diverse region experiencing fast economic growth and nutrition transition. We systematically examined 94 cohort studies on the associations of dietary and other lifestyle factors on non-communicable diseases (NCDs) in the region. These studies were mainly from China, Japan, the Republic of Korea, and Singapore. Patterns and changes in lifestyle risk factors for NCDs based on national surveys were examined. They showed some dietary intake improvements over the past three decades, featured as increased consumption of unsaturated oils, fruits, and vegetables, and decreased consumption of sodium and unhealthy fat. Despite a decrease in smoking rate and salt intake, the values remained higher than the global levels in 2019. The ultra-processed food intake in the region increased at a higher rate than the global estimate. National guidelines relevant to NCDs in five selected countries were highlighted. Strong future actions and policies are needed to tackle NCDs.

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Introduction

Over a quarter of the world's population lives in the World Health Organization (WHO) Western Pacific region, which includes 37 countries and regions with diverse geography, ethnicity, language, culture, and socioeconomic development levels. The region has been undergoing rapid shifts, such as economic development, population aging, lifestyle changes, disease burden, and technological innovation.[1] Non-communicable diseases (NCDs) in this region have been rising, especially obesity, diabetes mellitus (DM), cancers, and cardiovascular diseases (CVDs). The most important and modifiable NCD risk factors are unhealthy diets, smoking, alcohol consumption, and physical inactivity. Over the past 30 years, lifestyle factors have significantly shaped health outcomes in the Western Pacific region. According to the Global Burden of Diseases (GBD) studies, lifestyle factors, including tobacco use, unhealthy diet, and alcohol consumption ranked in the top 10 risks in both 1990 and 2019. Although the ranking did not change

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Key message

- A systematic review of 94 cohort studies from the Western Pacific region indicated that dietary intakes (n = 52) and other lifestyle factors (n = 42) had a profound influence on risks of non-communicable diseases (NCDs).
- In contrast to the consistent association between other lifestyle factors and NCDs, the associations between various measures of dietary intake and NCD outcomes appear to vary across countries.
- Improvements in dietary intakes were observed in the Western Pacific region over the past three decades, featured as increased consumption of unsaturated oils, fruits, and vegetables and decreased consumption of sodium and unhealthy fat.
- The Western Pacific region had lower intakes of sugar-sweetened beverages and processed meat than the global average, but the average annual percentage of change was higher. This increase was largely driven by some middle-income countries (e.g., China and Vietnam).
- Most countries in the Western Pacific region have released national dietary guidelines, and most of their specific guidelines for food groups and nutrients are similar. However, most countries have not yet implemented cost-effective policies to improve the food environment.
- Countries in the Western Pacific region need to set up strong national policies and programs to achieve the NCD global targets.

significantly, the relative rates associated with each lifestyle factor did increase substantially.[2] The burden of these factors is likely to continue to increase globally, including in the Western Pacific region.

With the fastest growing economies among countries, the dietary characteristics, food systems, and environments in the Western Pacific region are attracting international attention compared to other WHO regions. This is partly due to the region's diverse cultures, religions, and political systems. Diets in the Western Pacific region often include high levels of salt and seafood, which are influenced by traditional cooking styles and geographical location of the countries.[3] Furthermore, specific consumption patterns vary greatly across countries compared with those in other regions.[4] The 2015 China Adult Chronic Disease and Nutrition Surveillance showed decreased consumption of grains in general but increased consumption of refined grains in China since 1982.[5] Additionally, the nutrition-related environments in the Western Pacific region remain complex with various income levels ranging from lower middle-income countries (MICs), upper MICs, to high-income countries (HICs). Certain areas in lower MICs have less established food systems with predominantly traditional small farmer economies, farmers' markets, and wet markets, while in HICs with industrialized food systems. However, research on Western Pacific region is sparse. Few studies have examined trends in dietary intake and other lifestyle factors and their associations with NCDs in the region.

Although countries may have guidelines and policies regarding NCD prevention and control, it is unclear to what extent these guidelines and policies are consistent with international guidelines and recommendations on dietary and lifestyle factors. In addition, the implementation of the policies varies across countries, along with marked variations in their residents' socioeconomic status, dietary patterns, and lifestyles.[6]

The WHO regional office issued a Regional Action Framework for the Prevention and Control of NCDs in the Western Pacific region, which presents the region's vision, principal objectives, and recommended actions.[1] Long-term progress on NCD prevention and control aims at a whole-systems change that addresses the underlying causes of NCDs and takes a lifelong approach to address social inequalities while creating a health-enhancing environment. However, the characteristics of Western Pacific region centered on nutrition and other lifestyle factors were not identified, and future strategies were not presented.

This study aimed to 1) examine the associations of dietary and other lifestyle factors on NCDs in the Western Pacific region; 2) describe patterns and trends in dietary intakes and other lifestyle factors over the past three decades in the Western Pacific region; 3) compare national guidelines for NCD prevention and control in selected countries and compare them with those issued by the WHO; and 4) provide recommendations for future actions.

Methods

Associations of dietary factors and other lifestyle factors on NCDs

We conducted a systematic review to evaluate the associations of nutrition and lifestyle factors on NCDs in adults aged 19 years or older in the Western Pacific region. PubMed/MEDLINE and Embase were searched for studies published from January 1, 2000 to October 31, 2022, using the following terms in various combinations: "NCD", "NCDs", "non-communicable disease", "non-communicable diseases", "CVD", "CVDs", "cardiovascular diseases", "DM", "diabetes", "cancer", "cancers", "tumor", "tumors", "neoplasm", "neoplasms", "pulmonary disease", "respiratory disease", "COPD", "chronic obstructive", "chronic obstructive pulmonary disease", "obesity", "overweight", "BMI", "Western Pacific region", "Western Pacific region" or 37 countries, "dietary factors", "epidemiology", and "cohort studies".

The search was performed by selecting relevant terms for representative diseases and factors. We also manually searched the references of all included articles for relevant studies. The abstracts and titles, identified from the search, were screened by two review investigators to identify potentially relevant papers and their full text. Only studies with full text in English were included, and the full text was independently assessed using the inclusion criteria. These studies were included if they meet one or more of the following

criteria: 1) a single food, food group, dietary pattern or nutrients that affect the incidence of diseases; 2) studies with a sample size of more than 1000; and 3) studies not conducted on patients. Any disagreements were discussed with a third reviewer until reached a consensus.

Studies on the associations of the other lifestyle factors of "smoking", "alcohol", "physical activity" or "insufficient activity" on NCDs were searched using a similar approach as for dietary factors (Supplementary Table S1). We used forest plots to present hazard ratios for the associations between dietary intakes in the top quartile (Q4) or quintile (Q5) and NCDs.

For quality control, one reviewer conducted data extraction, and the other reviewer independently checked for accuracy. In addition, two investigators assessed the quality of included research with the Newcastle-Ottawa Scale (NOS) to assess the quality of the studies. After evaluating its three aspects (selection, comparability, and outcome), each study could be assigned nine stars at most. The quality of studies was ranked as low quality (below 3 stars), moderate quality (4–6 stars), and high quality (7–9 stars).

Analysis of the Global Burden of Diseases (GBD) data for 1990–2019

The age-standardized leading risk ranking and its change between 1990 and 2019 based on DALYs per 100,000 population from NCDs were obtained from the GBD compare tool.

To identify secular trends of dietary intakes and other lifestyle factors in the region, the data of dietary risk factors exposure and summary exposure values (SEV) for smoking, drinking, and physical activity were used to examine the changes in age-standardized dietary and nutrition among adults from the GBD results tool 1990–2019. Then, the average annual percentage of change and 95% uncertainty interval (UI) from 1990 to 2019 were calculated by regressing a log-linear function of age-standardized DALYs per 100,000 population a year. We configured the model to detect a maximum of five join points and avoid segments comprising only two data points.

National guidelines related to NCDs in selected countries

To compare national information on dietary factors and other lifestyle factors (i.e., smoking, alcohol use, and physical activity) across countries, we searched and reviewed recent national guidelines and reports from selected countries (i.e., China, Republic of Korea, Japan, Australia, and Viet Nam).

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Associations of dietary and other lifestyle factors on NCDs risks in the Western Pacific region

We conducted a systematic review of 94 cohort studies to investigate the associations of dietary intakes (n = 52) and other lifestyle factors (n = 42) on NCDs in the Western Pacific region (Table 1, Fig. 1 and Supplementary Table S2). Our main findings include: 1) dietary intakes had profound influences on NCDs, although the associations between various measures of dietary intakes and NCD outcomes across countries varied considerably; 2) a healthier lifestyle, evaluated by assessing other lifestyle factors like physical activity, smoking, and alcohol drinking, was associated with decreased risks of several NCDs; 3) there were very few studies on the associations of dietary intakes and lifestyle factors on the risks of respiratory diseases in the Western Pacific region, and future studies are warranted; and 4) most cohort studies were conducted in four countries, namely China, Japan, the Republic of Korea, and Singapore. In accordance with the NOS quality assessment scale for cohort studies, the quality scores were similar for studies on dietary intake or other lifestyle factors with NCDs (≥85% cohorts, ≥7 stars). Overall, they indicate high quality (Supplementary Tables S3 and S4).

Our systematic review identified 52 cohort studies examining the associations between different dietary factors and NCDs: for DM (n = 14), CVDs (n = 4), cancers (n = 33), and respiratory diseases (n = 1) in the Western Pacific region. Fig. 1 and Supplementary Table S2 summarize the key findings. Some main findings were: 1) decreased risk of DM was associated with increased dietary intakes of coarse grain,[7,8] fresh fruit,[9–11] wheat,[11] and vegetables,[8,11] while there was an increased risk with higher intakes of total fat and carbohydrates,[12] fish,[13] red meat,[11,13,14] and junk food[8]; 2) CVD risks were lower with higher intakes of peanuts,[15] unprocessed meats,[16] and total fiber[17]; 3) lower cancer risks were associated with several dietary patterns (i.e., the Alternative Healthy Eating Index updated in 2010,[18] an alternate Mediterranean diet score,[18] Dietary Approaches to Stop Hypertension [DASH],[18] a high-dairy and high-fruit-and-vegetable and low-alcohol pattern score,[19] and vegetable-fruit-soy pattern[20]), food groups (i.e., higher intakes of milk,[21,22] red meat,[23–25] vegetables,[26,27] and fruits,[26,28] as well as lower consumption of grilled meat,[29] high-cholesterol foods,[29] and processed meat intake[30]), some nutrients (i.e., lower sodium,[31,32] and saturated fat[33]); and 4) a higher risk of COPD was associated with lower fish intake[34] and in those with a smoking history.[35] Please see more results in Supplementary Table S2.

Forty-two cohort studies examined the associations between the other lifestyle factors and NCDs: DM (n = 4), CVDs (n = 5), cancers (n = 32), and respiratory diseases (n = 1) in the Western Pacific region (Table 1).

No.	Reference	Study setting	Participant characteristics Sample size; gender (men/women); age	Factors (exposure)	HR or RR (95% CI)	Effect on risk
1. Cardiovascular diseases (n = 5)						
1)	Jin et al., 2019	Republic of Korea	n = 501,690; 50%/50%; 47.6 ± 14.3 years	Physical activity level (MET-minutes/week) 500–1000 MET-minutes/week (Ref. 0 MET-minutes/week)	**Atrial fibrillation** HR = 0.88 (0.80–0.97)	Decrease
2)	Bennett et al., 2017	China	n = 487,334; 51%/59%; 51 years	Physical activity (MET-h/day)[b] Q5 (Ref. Q1)	HR = 0.77 (0.74–0.80)	Decrease
3)	Lin et al., 2021	China	n = 76,176; 40.7%/59.3%; 51.2 ± 11.8 years	Types of transport to get to and from work Cycling commuters (Ref. Non-active commuters)	HR = 0.71 (0.62–0.82)	Decrease
4)	Fan et al., 2019	China	n = 104,170; 48%/52%; 52.6 years	Types of transport to get to and from work 1) Cycling 2) Walking (Ref. Non-active commuting)	**Ischemic heart disease** 1) HR = 0.81 (0.74–0.88) 2) HR = 0.90 (0.84–0.96)	Decrease
5)	Woodward et al., 2005	Asia Australia, New Zealand	n = 562,338; 65%/35%; 46.5 years	Smoking Current smokers (Ref. Non-smokers)	HR = 1.42 (1.36–1.48)	Increase
2. Diabetes mellitus (n = 4)						
1)	Wakasugi et al., 2022	Japan	n = 31,039; Not reported; Not reported	Healthy lifestyle scores (HLSs)[d] 5 score (Ref. 0–2 score)	HR = 0.51 (0.32–0.81)	Decrease
2)	Lv et al., 2017	China	n = 461,211; 41%/59%; 30–79 years	Low-risk lifestyle factors[c] 1) Light-to-moderate alcohol consumption 2) Physical activity	1) HR = 0.77 (0.66–0.89) 2) HR = 0.88 (0.83–0.93)	Decrease
3)	Park et al., 2021	Republic of Korea	n = 5,198,792; 46%/54%; ≥20 years	Smoking 1) Non-smokers 2) Quitters (Ref. Current smokers)	1) HR = 0.62 (0.61–0.63) 2) HR = 0.86 (0.84–0.88)	Increase
4)	Sairenchi et al., 2004	Japan	n = 128,141; 31%/69%; 40–79 years	Smoking 1) Ex-smoker 2) Current smoker ≥20 cigarettes/day (Ref. Never-smoker)	1) HR = 1.10 (1.00–1.20) (Only men) 2) HR = 1.26 (1.15–1.37) (Men) HR = 1.38 (1.13–1.68) (Women)	Increase
3. Cancer (n = 32)						
1)	Bui et al., 2022	Republic of Korea	n = 15,175; 42.2%/57.8%; 51.5 ± 8.9 years	Physical activity (MET minutes/week) High, ≥2430 (Ref. Low, <693)	**Thyroid cancer** HR = 0.65 (0.44–0.94)	Decrease
2)	Pang et al., 2021	China	n = 460,937; Not reported; 52.0 ± 10.5 years	Physical activity (MET-h/day) ≥33.2 (Ref. <8.7)	**Liver cancer** HR = 0.81 (0.71–0.93) **Gallbladder cancer** HR = 0.51 (0.32–0.80) **Biliary tract cancer** HR = 0.55 (0.38–0.78)	Decrease
3)	Ko et al., 2020	Republic of Korea	n = 5,874,668; –/100%; 46.8 ± 14.5 years	1) Exercise <3–4 times/week (Ref. ≥3–4 times/week) 2) Alcohol ≥1–2 times/week (Ref. <1–2 times/week)	**Lung cancer** 1) HR = 1.33 (1.27–1.40) 2) HR = 1.25 (1.21–1.28)	1) Decrease 2) Increase

(Table 1 continues on next page)

No.	Reference	Study setting	Participant characteristics Sample size; gender (men/women); age	Factors (exposure)	HR or RR (95% CI)	Effect on risk
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4)	Kim et al., 2019	Republic of Korea	n = 257,854; 50.5%/49.5%; 50.7 years	Physical activity Exercise 3–4 or 5–6 times/week (Ref. No exercise)	**Stomach cancer** HR = 0.87 (0.79–0.96) **Lung cancer** HR = 0.80 (0.71–0.91) **Liver cancer** HR = 0.85 (0.75–0.98)	Decrease
5)	Eaglehouse et al., 2017	Singapore	n = 63,257; 44.5%/55.5%; 56.4 ± 8.0 years	Physical activity Strenuous-Vigorous (Intensity ≥1/2 h/week) (Ref. None)	**Colorectal cancer** HR = 0.85 (0.74–0.99)	Decrease
6)	Suzuki et al., 2008	Japan	n = 30,157; –/100%; 40–69 years	Physical activity Walked for ≥1 h/day and exercised for ≥1 h/week (Ref. Walked for <1 h/day and exercised for <1 h/week)	**Breast cancer** HR = 0.45 (0.25–0.78)	Decrease
7)	Lee et al., 2007	Japan	n = 65,022; 46%/54%; 40–69 years	MET (hours/day) Highest (Ref. Lowest)	**Total colorectal cancer** RR = 0.69 (0.49–0.97)	Decrease
8)	Lee et al., 2022	Republic of Korea	n = 128,218; 33%/67%; 40–69 years	1) Alcohol consumption status Drinker (Ref. Non-drinker) 2) Alcohol consumption frequency ≥5 times/week (Ref. Non-drinker) 3) Amount of ethanol consumed >30 g/week (Ref. Non-drinker)	**Gastric cancer** 1) HR = 1.31 (1.03–1.66) (Only men) 2) HR = 1.62 (1.17–2.25) (Only men) 3) HR = 1.47 (1.08–1.99) (Only men)	Increase
9)	Im et al., 2021	China	n = 510,137; 41%/59%; 52.0 ± 10.7 years	Alcohol drinking status Current regular drinkers (Ref. Abstainers)	**Mouth and throat cancer** HR = 1.73 (1.51–1.99) (Only men) **Esophagus cancer** HR = 1.80 (1.66–1.96) (Only men) **Gallbladder and biliary tract cancer** HR = 1.33 (1.09–1.62) (Only men)	Increase
10)	Im et al., 2021	China	n = 492,643; 41%/59%; 52.0 ± 10.7 years	Alcohol drinking status Current regular drinkers per 280 g/week (Ref. Abstainers)	**Liver cancer** HR = 1.44 (1.23–1.69) (Only men)	Increase
11)	Iwase et al., 2021	Japan	n = 158,164; –/100%; 40–104 years	1) Alcohol drinking frequency Regular (≥5 days/week) (Ref. Non) 2) Alcohol drinking amount (g/day) ≥23 g/day (Ref. 0 g/day)	**Breast cancer** 1) HR = 1.37 (1.04–1.81) (Only premenopausal women) 2) HR = 1.74 (1.25–2.43) (Only premenopausal women)	Increase
12)	Makiuchi et al., 2019	Japan	n = 103,143; 46.9%/53.1%; 40–69 years	1) Alcohol drinking Regular drinkers (Ref. Non/occasional drinkers) 2) Smoking Current smokers with ≥30 pack-years (Ref. Non-smoker)	**Intrahepatic bile duct cancer** 1) HR 3.48 (1.41–8.61) 2) HR 2.25 (1.19–4.25)	Increase
13)	Yang et al., 2019	South Korea	n = 4578; Not reported; Not reported	Alcohol consumption More than 30 g/day in men and 20 g/day in women (Ref. Without significant alcohol consumption)	**Colorectal neoplasm** HR = 1.86 (1.28–2.70)	Increase

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No.	Reference	Study setting	Participant characteristics Sample size; gender (men/women); age	Factors (exposure)	HR or RR (95% CI)	Effect on risk
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14)	Lu et al., 2018	Japan	n = 95,525; 47%/53%; Not reported	1) Alcohol drinking (g/week) ≥300 (Ref. Never/None) 2) Smoking Current (pack-years) ≥60 (Ref. Never/None)	**Oral cavity cancer** 1) HR = 3.79 (1.73–8.27) 2) HR = 5.20 (2.24–12.06) **Hypopharyngeal cancer** 1) HR = 10.11 (1.73–8.27) 2) HR = 20.92 (2.29–191.12)	Increase
15)	Wang et al., 2017	China	n = 63,527; Not reported; Not reported	1) Alcohol Daily ethanol intake ≤8.1 g (Ref. Daily ethanol intake >8.1 g) 2) Smoking Pack-years of smoking ≤21.9 (Ref. Pack-years of smoking >21.9)	**Gastric adenocarcinoma** 1) HR = 0.69 (0.53–0.89) 2) HR = 0.66 (0.55–0.83)	Increase
16)	Sawada et al., 2014	Japan	n = 48,218; 100%/–; Not reported	Alcohol consumption 150–300 g/week (Ref. Non-drinkers)	**Advanced prostate cancer** HR = 1.51 (1.04–2.19)	Increase
17)	Shimazu et al., 2012	Japan	n = 174,719; 51.4%/48.6%; 40–79 years	1) Alcohol intake (g/day) 69.0–91.9 (Ref. <once/week) 2) Alcohol intake (g/day) ≥23.0 (Ref. <once/week)	**Liver cancer** 1) HR = 2.18 (1.24–3.86) (Only men) 2) HR = 3.60 (1.22–10.66) (Only women)	Increase
18)	Koh et al., 2011	Singapore	n = 61,321; Not reported; Not reported	1) Alcohol intake More than two drinks/day (Ref. Non-drinkers) 2) Smoking status Current smoker (Ref. Never smoker)	**Hepatocellular carcinoma** 1) HR = 2.24 (1.46–3.41) 2) HR = 1.63 (1.27–2.10)	Increase
19)	Moy et al., 2010	China	n = 18,244; 100%/–; 45–64 years	1) No. drinks of alcoholic beverages/day ≥4 (Ref. Non-drinkers) 2) Smoking Ever smokers Former smokers Current smokers (Ref. Never smokers)	**Gastric cancer** 1) HR = 1.46 (1.05–2.04) 2) HR = 1.59 (1.27–1.99) HR = 1.79 (1.25–2.57) HR = 1.55 (1.23–1.96)	Increase
20)	Tsong et al., 2007	Singapore	n = 63,257; Not reported; 45–74 years	1) Alcoholic drinks Seven or more/week (Ref. Non-drinkers) 2) Cigarette smoking Heavy smokers (Ref. Non-smokers)	**Colon cancer** 1) HR = 1.72 (1.33–2.22) **Rectal cancer** 2) HR = 2.64 (1.77–3.96)	Increase
21)	Otani et al., 2003	Japan	n = 90,004; 47%/53%; 40–69 years	1) Alcohol drinking 300 g/week or more (Ref. Non-drinkers) 2) Smoking Current smoking (Ref. Never-smokers)	**Colorectal cancer** 1) RR = 2.1 (1.6–2.7) 2) RR = 1.4 (1.1–1.8) (Only men)	Increase

(Table 1 continues on next page)

No.	Reference	Study setting	Participant characteristics Sample size; gender (men/women); age	Factors (exposure)	HR or RR (95% CI)	Effect on risk
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22)	Luu et al., 2022	China	n = 61,321; 45%/55%; 45–74 years	Smoking status and BMI 1) Never smoking and BMI <20.0 or >23.0 2) Never smoking and BMI 20.0–23.0 (Ref. Ever smoking and BMI <20.0 or >23.0)	**Pancreatic cancer** 1) HR = 0.91 (0.67–1.24) 2) HR = 0.68 (0.47–1.00)	Increase
23)	Park et al., 2020	Republic of Korea	n = 6,569,144; Not reported; 55.4 years/54.8 years	Smoking 1) Former 2) Current (Ref. Never)	**Lung cancer** 1) HR = 1.27 (1.23–1.33) (Men) HR = 1.45 (1.16–1.81) (Women) 2) HR = 2.71 (2.63–2.79) (Men) HR = 2.70 (2.48–2.94) (Women)	Increase
24)	Saito et al., 2017	Japan	n = 321,501; 48%/52%; ≥35 years	Smoking cessation 16–20 years (Ref. Never)	**Total cancer** HR = 1.21 (1.05–1.38) (Only men)	Increase
25)	Chen et al., 2015	China	n = 512,891; 41%/59%; 30–79 years	Smoking 1) Smoking category Ex-smoker Smoker (Ref. Never-smoker) 2) Age of starting smoking (mean) <20 years (16.8 years) (Ref. Never-smoker) 3) Mean cigarette equivalents/day ≥25 (35.2) (Ref. Never-smoker)	**All cancer** 1) HR = 1.15 (1.06–1.24) HR = 1.44 (1.41–1.48) 2) HR = 1.61 (1.54–1.69) 3) HR = 1.72 (1.63–1.82) **Lung cancer** 1) HR = 1.53 (1.28–1.81) HR = 2.51 (2.37–2.66) 2) HR = 3.17 (2.91–3.46) 3) HR = 3.59 (3.22–3.99)	Increase
26)	Wong et al., 2010	Singapore	n = 45,900; 40.7%/59.3%; 55.5 years	Smoking Never smokers (Ref. Current smokers)	**Lung cancer** HR = 0.14 (0.11–0.18)	Increase
27)	Luo et al., 2007	Japan	n = 99,670; 47.7%/52.3%; 30–79 years	Smoking Current (Ref. Never)	**Pancreatic cancer** HR = 1.8 (1.1–3.0) (Only men)	Increase
28)	Niwa et al., 2005	Japan	n = 34,639; –/100%; 58.3 years	Smoking 1) Cigarettes/day 10–19 (Ref. Never smokers) 2) Years smoked 10–19 (Ref. Never smoked) 3) Pack-years 10–19 (Ref. Never smoked)	**Ovarian cancer** 1) RR = 3.50 (1.05–11.68) 2) RR = 4.58 (1.07–19.59) 3) RR = 5.56 (1.68–19.06)	Increase
29)	Inoue et al., 2004	Japan	n = 92,792; 48%/52%; 52.9 ± 7.9 years/53.3 ± 8.0 years	Smoking 1) Former smokers 2) Current smokers (Ref. Never-smokers)	**Total cancer** 1) HR = 1.37 (1.22–1.54) (Men) HR = 1.47 (1.05–2.05) (Women) 2) HR = 1.64 (1.48–1.82) (Men) HR = 1.46 (1.21–1.75) (Women)	Increase

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No.	Reference	Study setting	Participant characteristics Sample size; gender (men/women); age	Factors (exposure)	HR or RR (95% CI)	Effect on risk
(Continued from previous page)						
30)	Jee et al., 2004	Republic of Korea	n = 1,212,906; 68%/32%; 45.0 ± 10.9 years/48.6 ± 12.4 years	Smoking 1) Current smoker 2) Former smokers (Ref. Never smoker)	(Only men) **Esophagus cancer** 1) RR = 3.1 (2.4–4.0) 2) RR = 1.6 (1.2–2.1) **Stomach cancer** 1) RR = 1.5 (1.4–1.6) 2) RR = 1.4 (1.3–1.5) **Liver cancer** 1) RR = 1.1 (1.0–1.2) 2) RR = 1.3 (1.2–1.4) **Bile duct cancer** 1) RR = 1.4 (1.1–1.8) 2) RR = 1.4 (1.1–1.8) **Pancreas cancer** 1) RR = 1.5 (1.2–1.8) 2) RR = 1.4 (1.1–1.7) **Larynx cancer** 1) RR = 5.4 (3.5–8.1) 2) RR = 3.3 (2.1–5.1) **Lung cancer** 1) RR = 4.0 (3.5–4.4) 2) RR = 2.0 (1.7–2.3) **Bladder cancer** 1) RR = 2.0 (1.7–2.5) 2) RR = 1.8 (1.4–2.2)	Increase
31)	Koizumi et al., 2004	Japan	n = 29,392; 100%/–; Not reported	Smoking 1) Current smokers 2) Past smokers (Ref. Never smoked)	**Gastric cancer** 1) RR = 1.84 (1.39–2.43) 2) RR = 1.77 (1.29–2.43)	Increase
32)	Mizoue et al., 2000	Japan	n = 4050; 100%/–; Not reported	Smoking 1) Ex-smoker 2) Current smoker (Ref. Never smoked)	**Liver cancer** 1) RR = 2.9 (1.0–8.4) 2) RR = 3.3 (1.2–9.5)	Increase
4. Respiratory diseases (n = 1)						
1)	Leem et al., 2018	Republic of Korea	n = 6517; 46.0%/54.0%; Not reported	Smoking history ≥20 pack-years (Ref. = Never)	**COPD** RR = 2.54 (2.09–3.08)	Increase

MET, metabolic equivalent of task; HR, hazard ratio; HLS, healthy lifestyle scores; RR, relative risk; CI, confidence interval. [a]Please see the tables with references in the Supplemental Files. Exposure factors show the associations between dietary intakes in the top quartile (Q4) or quintile (Q5) and NCDs. [b]Total physical activity was calculated as MET hours per day (MET-h/day) by multiplying the MET of each activity (occupational tasks, commuting, household tasks, and leisure time activities) by the frequency and duration of physical activity. [c]Low-risk lifestyle factors included: drinking greater than zero but less than 30 g of alcohol per day; engaging in a sex-specific upper quarter of the physical activity level. Each factor was bisected and analyzed. [d]The HLS was calculated as the sum of the score from each component (smoking, body mass index, regular exercise, eating habits, alcohol intake) and ranged from 0 (least healthy) to 5 (healthiest).

Table 1: **Findings from 42 studies on the associations between other lifestyle factors and cardiovascular diseases (n = 5), diabetes mellitus (n = 4), cancers (n = 32) and respiratory diseases (n = 1) in the Western Pacific region[a].**

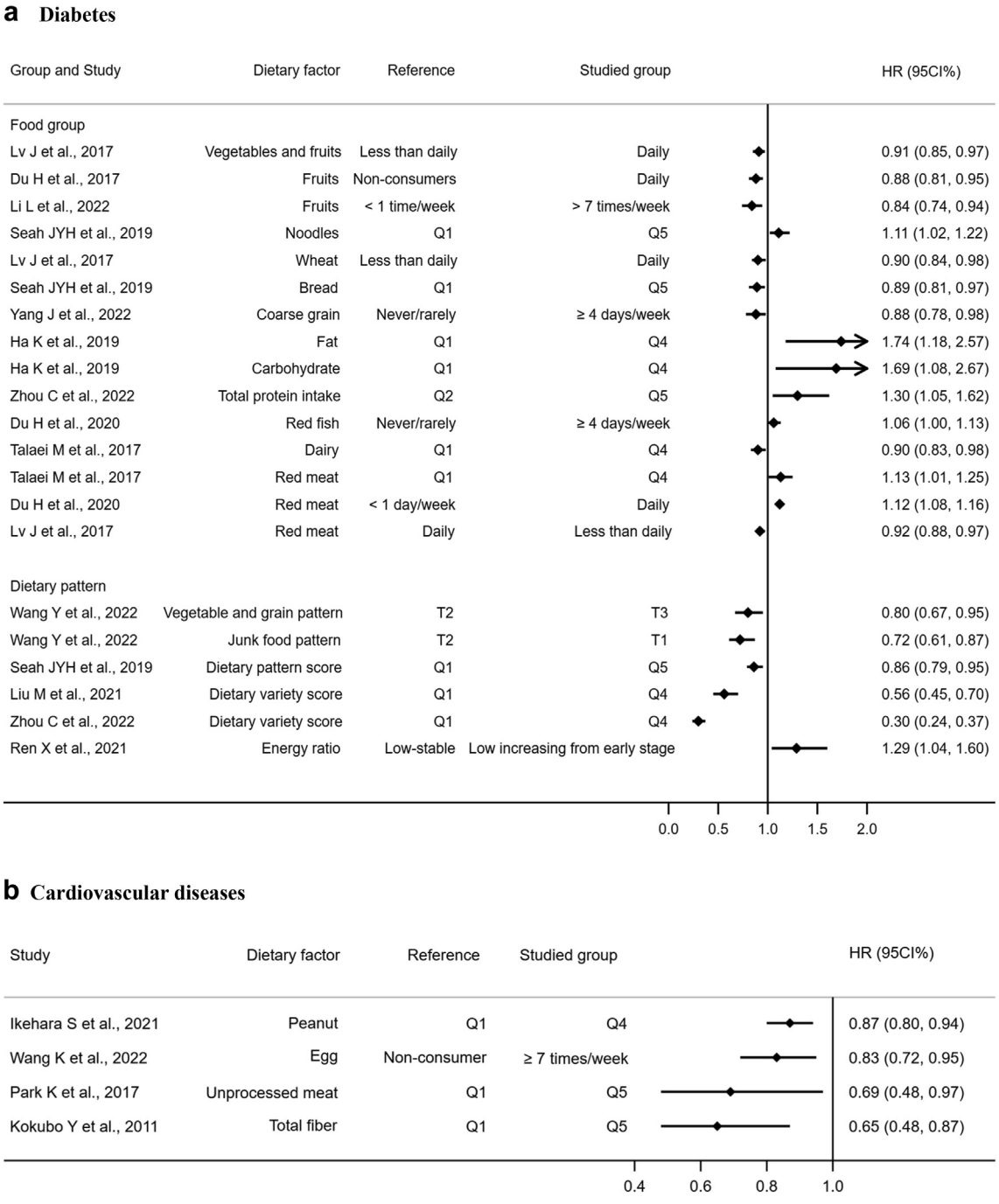
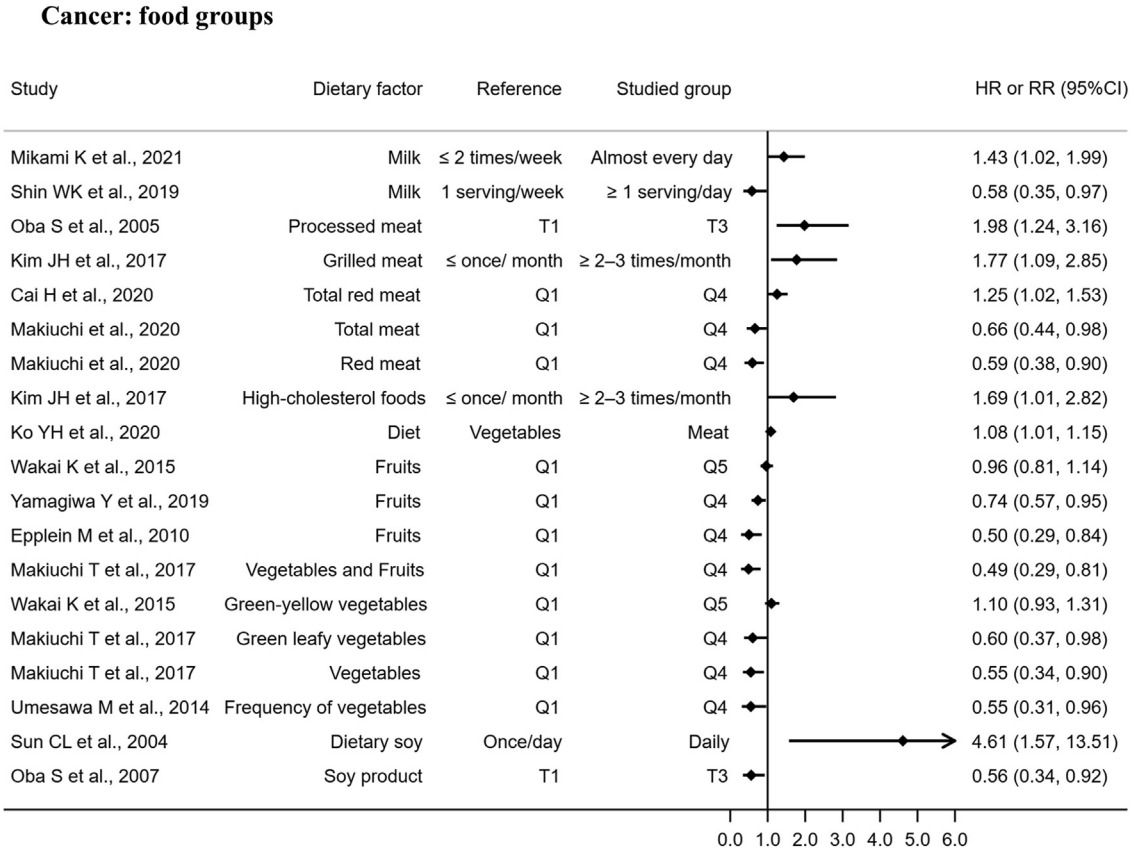


Fig. 1: **Associations (hazard ratios and 95% CI) between dietary intake and diabetes (a; n = 14), cardiovascular diseases (b; n = 4), and cancer (c and d; n = 33) based on findings from 51 cohort studies in the Western Pacific region.** A forest plot showing the associations between dietary intake in the top quartile (Q4) or quintile (Q5) and NCDs. aMED, the alternate Mediterranean diet; AHEI-2010, the Alternative Health Eating Index-2010; DASH, the Dietary Approaches to Stop Hypertension; DFA, a high-dairy & high-fruit-and-vegetable & low-alcohol; HR, hazard ratio; RR, relative risk; PUFA, polyunsaturated fatty acid; CI, confidence interval; T, tertile.

Overall, a healthier lifestyle, as mainly determined by a comprehensive evaluation of physical activity, smoking, and drinking was associated with a decreased risk of several NCDs. We found that 1) increased levels of physical activity, including commuting transportation, was associated with reduced risk of DM,[11] CVD,[36] and



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cancer[24]; 2) smoking was associated with an increased risk of CVD,[37] DM,[38,39] and cancer,[40,41]; even former smokers who have quit still face a higher risk of these health issues than those who have never smoked; 3) alcohol consumption was associated with an increased risk of cancer,[24,40] whereas light drinking was associated with a decreased DM risk.[11]

Overall, the main findings in the Western Pacific region were consistent with those in other regions. However, compared to studies conducted in other regions, the cohorts identified primarily consisted of participants from four upper MICs or HICs. This limitation may have constrained the generalizability of our findings. Second, there was a lack of research on several lifestyle factors (i.e., sugar-sweetened beverages [SSBs], fruit juice, and alcoholic beverages)[42,43] and on those that represent the unique culture of each Western Pacific region country. For example, dietary patterns such as the Alternative Healthy Eating Index updated in 2010[18] and Dietary Approaches to Stop Hypertension (DASH) used in those cohorts were mainly developed from studies in other regions. Moreover, some of the above results were mainly based on some single cohort studies in the region, although the quality scores of cohorts were high. Finally, due to the limitations of the identified cohort studies (e.g., inadequate comparable results), we could not conduct a meta-analysis.

These cohort studies qualitatively showed that dietary patterns and other lifestyle factors have important associations with NCDs in the Western Pacific region.[42,43] The finding were also supported by the representative but limited results from randomized controlled trials (RCTs). For example, the Japan Diabetes Prevention Program reported that a 3-year lifestyle intervention (diet or exercise) significantly reduced the cumulative incidence of type 2 DM among participants with impaired glucose tolerance.[44] Supportively, the Da Qing Diabetes Preventive Study with much longer follow up (≥30-year) reported lifestyle intervention (diet, exercise, or diet plus exercise) could not only effectively delay the onset of type 2 DM, but also reduce the incidence of diabetes-related diseases compared with the control.[45] Unprecedented growth in the use and availability of social media afforded new avenues for supporting lifestyle intervention against NCDs at low cost. However, mHealth lifestyle interventions targeting improve diet and exercise for NCDs in the Western Pacific region have been limited to upper MICs or HICs; additionally,

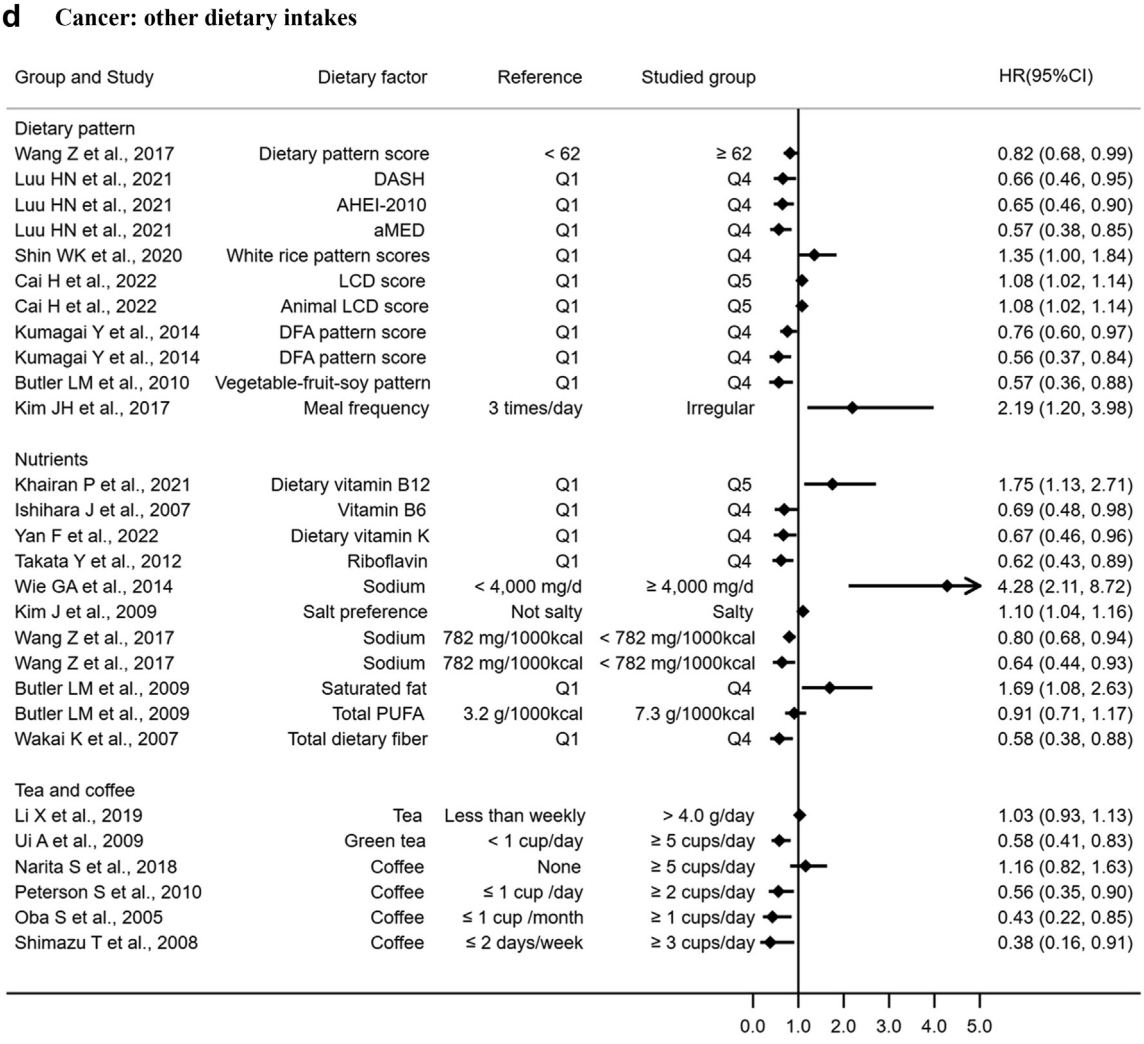

Fig. 1: Continued.

these interventions primarily focused on NCD populations and relied on relatively simple interventions, such as text messages and WeChat.[46,47] In comparison, other regions, such as the US, have employed more sophisticated approaches by combining websites with wearable devices for lifestyle interventions.[46,47]

Patterns in dietary intakes and other lifestyle behaviors in the Western Pacific region

Countries in the Western Pacific region have been experiencing a nutrition transition accompanied by urbanization, economic development, and technological advancement.[4] Overall, these countries have made favorable changes, featured by increased consumption of fruits and vegetables as well as decreased intakes of salt and unhealthy fat.[48–61] These were also supported by the risk ranking between 1990 and 2019 based on the GBD data (Table 2, Supplementary Table S5, and Fig. 2).

Despite the decreased rates of smoking in the last 30 years, smoking remained the second leading behavioral risk factor for DALYs in the Western Pacific region (Fig. 2). The increased absolute number of smokers in MICs may explain the high attributable risk of smoking to DALYs in the Western Pacific region.[2] In addition, high salt and alcohol use were among the top-ten contributors to DALYs in both 1990 and 2019. Other dietary risks and low physical activity had minor changes from 1990 to 2019, except for low vegetable consumption.

The Western Pacific region has an increased consumption of ultra-processed foods (i.e., meat and SSB) over the last 30 years. Overall, there was an increase in the consumption of processed and red meats, especially in upper MICs (i.e., China) and HICs (i.e., Australia, Japan, and the Republic of Korea),[52–58] consistent with the global trends.[63] The mean intakes of red meat (g/day; median IQR) in Australia (83.7 [79.2–88.6]) was

Countries	References	Dietary intakes (A)	Other lifestyle factors (B)
China	Huang L et al., 2021[48] (A) 2020 Report on Nutrition and Chronic Disease Status of Chinese Residents[49] (A) 2021 Scientific Research Report on Dietary Guidelines for Chinese Residents[50] (B) Zhang M et al., 2022[51] (B)	**1) Dietary structure shifted from plant-based diets to animal-and plant-based diets from 1982 to 2015–2017** • The intakes of cereals, fruit, and vegetables declined from 509.7 g/day to 305.8 g/day, 37.4 g/day to 41.9 g/day, and 316.1 g/day to 265.9 g/day. • Animal foods increased from 52.6 g/day to 137.7 g/day dominated by livestock and pork intake, increased from 34.2 g/day to 89.7 g/day. **2) Marked increase in fat to total energy intake** The percentage of energy intake from carbohydrates declined from 70.8% to 53.4% but the contribution of fat to total energy intake increased from 18.4% to 34.6% from 1982 to 2015–2017. **3) High consumption of cooking oil and salt** Daily cooking oil intake increased from 29.5 g/day to 43.2 g/day. Although salt intake decreased from 13.9 g/day to 9.3 g/day from 1992 to 2015–2017, it remains high.	**1) Smoking** The prevalence of current smoking decreased from 58.4% to 50.8% in men and remained low at around 2% in women from 2007 to 2018. **2) Alcohol** • The prevalence of current alcohol use among adults (≥18 years) was 61.7% in men and 20.3% in women during 2015–2017. • An increase was observed from 2007 to 2015 in urban areas (14.9% vs. 23.7%) but not in rural areas among women. **3) Physical activity (PA)** • Total amount of PA was largely decreased dominated by occupational PA. • From 2000 to 2018, PA decreased by an average of 9.3 MET-h/w (equivalent to 79.7 kcal/day) in men, and 8.2 MET-h/w (equivalent to 64.7 kcal/day) in women.
Republic of Korea	Korean Health Statistics 2021: Korea National Health and Nutrition Examination Survey (KNHANES VIII-3)[52] (A) Chang Y et al., 2019[53] (B) Kim SY et al., 2021[54] (B) Sung H et al., 2022[55] (B)	**1) About 80% of adults consume adequate energy, and the energy composition ratio has changed from 2012 to 2021** • Women have a higher rate of undernutrition than men (13.3% vs. 19.9%), and a lower rate of excess intake (5.5% vs. 6.8%). • The percentage of energy from carbohydrates decreased from 64.9% to 59.4%, while the percentage of energy from fat increased from 20.4% to 24.6%. **2) Low consumption of fruits and vegetables from 2012 to 2021** • Adherence to the recommended amount of vegetables and fruits (500 g/day) substantially is low and decreased from 39.0% to 28.1%. • The percentage of those who met the recommendation decreased from 42.2% to 30.7% in men, and 35.9% to 25.5% in women. **3) High consumption of saturated fat and salt from 2013 to 2021** • Saturated fat intake increased from 14.8 g/day to 16.7 g/day, and more than half consume more than the recommended amount of saturated fat. • Salt intake decreased from 9.6 g/day to 7.6 g/day, but 2/3 consume more salt than the recommended amount.	**1) Smoking** • The prevalence of smoking decreased in both men (71.7%–39.7%) and women (6.5%–3.3%) from 1992 to 2016. **2) Alcohol** • Daily alcohol consumption increased from 8.4 g in 1998 to 15.0 g in 2016–2018: in women from 2.1 g to 5.8 g and in men from 14.8 g to 23.9 g. • Alcohol intake was highest in men aged 30–49 years and women aged 19–29 years. **3) Physical activity** • The adherence rate to aerobic activity guidelines (a minimum of 150 min moderate to vigorous PA weekly) decreased from 57.0% in 2014 to 45.6% in 2019. • The adherence rate to muscle-strengthening activity guidelines (a minimum of two days weekly) increased slightly from 20.8% to 23.3% during 2014–2019 but was still low.
Japan	Fauzi et al., 2022[56] (A) National Health and Nutrition Survey[62] (A and B)	**1) Decreasing trend in total energy intake from 1995 to 2019** Total energy intake among adults (≥20 years) declined from 2327 to 2141 kcal/day in men and 1855 to 1717 kcal/day in women from 1995 to 2019. **2) Decreasing trend in total protein intake from 1995 to 2019** Total protein intakes among adults (≥20 years) declined from 92.5 to 78.8 g/day in men and 75.7 to 66.4 g/day in women from 1995 to 2019. **3) Main protein sources showed opposite trends from 2001 to 2019** Meat intake increased from 87.6 to 117.4 g/day in men and 62.4 to 86.7 g/day in women, whereas fish intake declined from 116.3 to 76.3 g/day in men and 91.6 to 61.7 g/day in women.	**1) Smoking** The prevalence of current smokers among adults (≥20 years) decreased from 52.7% to 27.1% in men, and slightly decreased from 10.6% to 7.6% in women from 1995 to 2019. **2) Alcohol** The prevalence of habitual drinkers (>3 times/week) among adults (≥20 years) decreased from 54.4% to 33.9% in men, and slightly increased from 7.4% to 8.8% in women from 1995 to 2019. **3) Physical activity** • The average daily step count among adults (≥20 years) decreased from 7849 to 6793 step/day in men, and 6820 to 5832 step/day in women from 1995 to 2019. • The percentage of adults (≥20 years) with exercise habits slightly increased from 26.6%

(Table 2 continues on next page)

Countries	References	Dietary intakes (A)	Other lifestyle factors (B)
(Continued from previous page)			
		The mean vegetable intake was 280.5 g in all participants, 288.3 g in men, and 273.6 g in women with no significant change over the past 10 years (2009–2019). **4) High salt consumption from 1995 to 2019** Salt intake declined from 15.0 to 10.9 g/day in men and 13.0 to 9.3 g/day in women, but remains higher than the Health Japan 21 target of 8.0 g/day and WHO recommended level of 5.0 g/day.	to 33.4% in men, and 22.3% to 25.1% in women from 1995 to 2019. Exercised regularly means performing physical activities for at least 30 min per session, at least twice a week, for at least one year.
Australia	Australian Bureau of Statistics, 2020–2021[57] (A and B) Australian Institute of Health and Welfare, 2018[58] (A and B)	**1) About 1/3 of Australians' energy comes from discretionary food that is high in energy and low in nutrients** **2) Adherence to the recommended serving of vegetables, fruit, grains, meat and alternatives, and dairy products and alternatives is low** • Over 2/5 (44.8%) met the fruit recommendation; almost 1/10 (8.7%) met the vegetable recommendation; 6.1% met both. Women were more likely to meet any of the recommendations than men. **3) Consumed more sugars, saturated fat and sodium than recommended** • Consume an average of 42–65 g of added sugars a day, higher for men than women. • Saturated and trans fats contribute 12% towards energy intake, similar for men and women. • Consume more than 5.5 g/day, which is well above the adequate intake level of 2.3 g/day, higher for men than women.	**1) Smoking** • 61.2% have ever smoked, and 10.7% were current daily smokers. • 9.3% have used an e-cigarette or vaping device at least once in their lives. **2) Alcohol** • 1/4 exceeded the Australian Adult Alcohol Guideline (≤10 standard drinks/week and ≤4 standard drinks/day) in 2020–2021 (25.8%). • Men were more likely than women to exceed the guideline (33.6% compared to 18.5%). **3) Physical activity** • 27.2% of people (≥15 years) met the PA guidelines. • 73.4% of people aged 18–64 years undertook 150 min or more of PA in the last week. • Nearly half (49.4%) of employed people aged 18–64 years described their day at work as mostly sitting.
Viet Nam	Vietnam National Institute of Nutrition, 2021[59] (A and B) Vietnam Ministry of Health, 2021[60] (A and B) Nguyen TT et al., 2018[61] (A)	**1) A balanced distribution of macronutrients** • Over the last 20 years (2000–2022), although the energy intake changes slightly from 1931 kcal/day to 2023 kcal/day, the ratio of the energy from three macronutrients is considered as balance. • The percentage of energy from carbohydrates decreased from 74.8% to 64.0%, protein from 13.2% to 15.8%, and fats from 12.0% to 20.2%. **2) Acceptable adherence to the recommended consumption of fruits and vegetables** From 2000 to 2020, although the intake of fruits increased from 62.4 g/day to 140.7 g/day and vegetables from 178.6 to 231.0 g/day, it only achieved 66.4%–74.4% of the recommendation. **3) Decreased rice intake and increased intakes of meat and fats from 2000 to 2020** • Rice intake decreased from 397.3 g/day to 325.5 g/day. • Meat intake increased from 51.0 g/day in 2000 to 136.4 g/day in 2020 nationwide and 155.3 g/day in urban areas, which was higher than the recommendation of 60–84 g/day. • Fat intake increased from 25.0 g/day to 45.5 g/day, and more than half was from animal sources.	**1) Smoking** • The prevalence of current smoking in men decreased from 59.4% in 2010 to 41.1% in 2020; and from 1.7% to 0.6% in women. • In 2020, second-hand smoke at home was 37.4% in men and 37.1% in women, which is lower than corresponding the rate in 2010 of 77.2% and 69.2%. **2) Alcohol** • In 2020, the prevalence of current alcohol use (in the last 30 days) was 64.2% in men, slightly lower than that in 2010 (69.6%); the prevalence increased in women from 5.6% in 2010 to 9.8% in women (18–69 years). • In 2020 among alcohol drinkers, drinking once every 2 days was 70.0% in men and 88.5% in women, respectively. **3) Physical activity** • The proportion of adults who did not meet the WHO recommendation (i.e., ≤150 min moderate-intensity PA per week) was 22.2% for both sexes; 16.1% in men and 28.3% in women. • The median duration of total PA/day has increased from 129 min in 2010 to 188 min in 2020.

Table 2: **Patterns of dietary and other lifestyle based on national data in selected countries in the Western Pacific region.**

higher than those in the US and selected western countries: the US, 48.5 (47.1–49.9); Canada, 46.1 (44.3–47.9); Mexico, 45.9 (40.9–51.0),[64] which were comparable with those in China (49.8; 46.5–53.3) and the Republic of Korea (46.2; 43.4–49.1). Interestingly, the Western Pacific region had a lower intake of SSB than the global average, but the average annual percentage of change was higher (2.8% vs. 1.3%). This

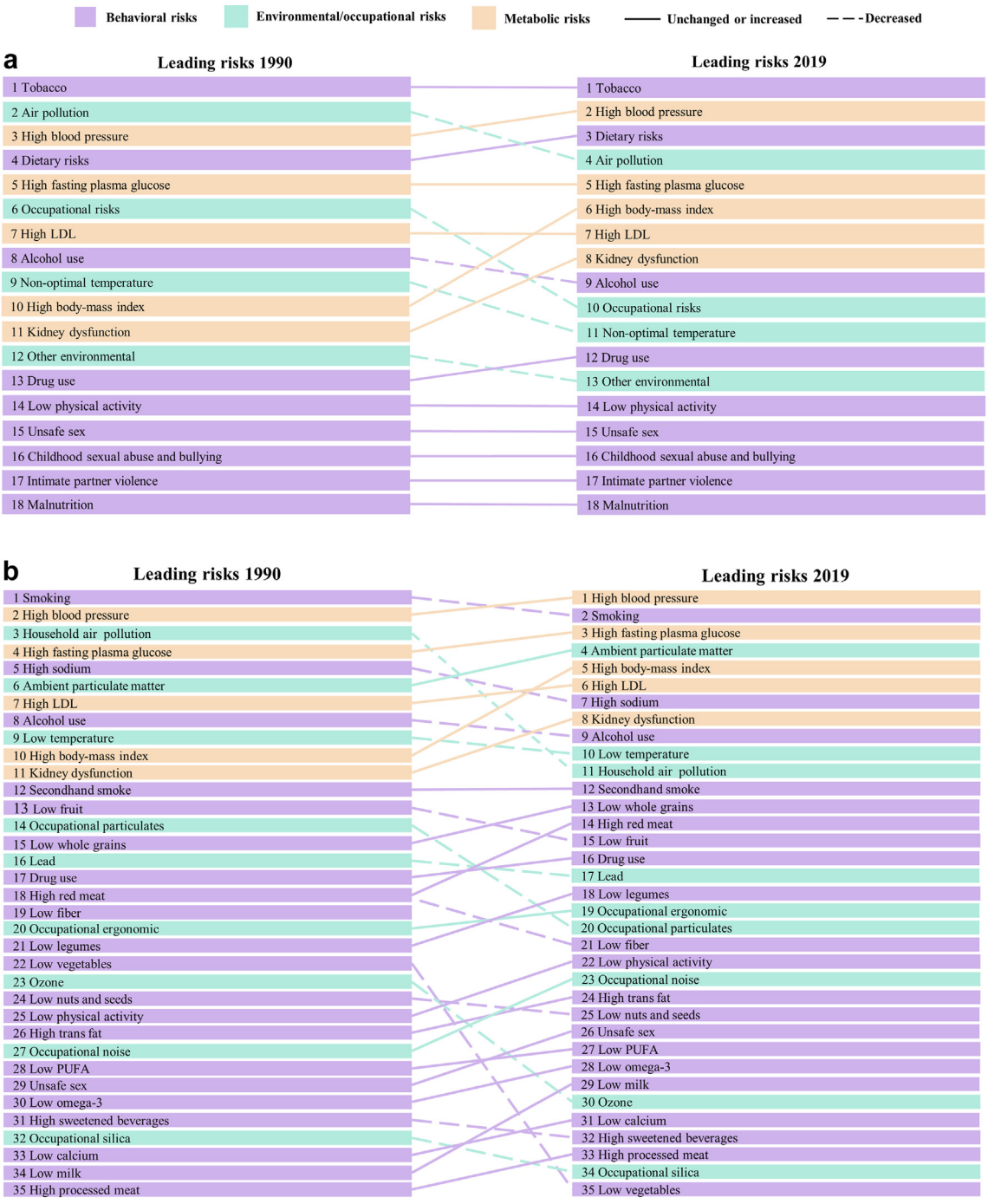

Fig. 2: **Age-standardized leading 18 risk factors (a) and 35 risk factors (b) ranking and its change between 1990 and 2019 based on DALYs per 100,000 from non-communicable diseases for both sexes and all ages in the Western Pacific region from 1990 to 2019.** *Data were obtained from the GBD compare tool: https://vizhub.healthdata.org/gbd-compare/#0. The data were age-standardized DALYs per 100,000. Solid lines are increases and dashed lines are decreases; DALYs, disability-adjusted life-years.

increase was largely driven by some MICs (e.g., China and Vietnam). In China, SSB intake increased substantially from 7.1 g/day in 1990 to 31.7 g/day in 2019, and 5.8 g/day to 19.4 g/day in Viet Nam. In contrast, SSB intake remained stable in some HICs (e.g., Japan and Australia). These results suggest that specialized

intervention strategies are needed to support the consumption of minimally processed foods in some MICs and HICs in the Western Pacific region.

Patterns in dietary intakes varied across the Western Pacific region. For example, vegetable consumption increased in Viet Nam, but decreased in China, Australia, and Japan.[48–51,56–61] Although salt intake in China and Japan slightly decreased, the intake of almost 10.0 g/day was still among the highest in the Western Pacific region and double that of the WHO's recommended limit of below 5 g/day.[65] In addition to wide variations in urbanization and economic development within the region, other factors such as geography, ethnicity, and culture might explain the shifts in dietary intakes among countries in the Western Pacific region. This diversity may be a factor in the heterogeneity of nutrition transition within the various countries. It may therefore be advantageous to establish dietary guidelines for NCD prevention based on geography and local culture, as in the case of Japan, whose dietary guidelines recommend taking advantage of the local dietary culture and local food products while incorporating new and different dishes.[54–58,66]

Over the last 30 years, the exposure risk presented by low physical activity and alcohol use consistently increased, while smoking decreased across the region. Nevertheless, smoking rates and alcohol consumption in the Western Pacific region were higher than those at the global level. Specifically, Australia and Japan, with higher incomes, also had the highest exposure risk for alcohol use but had a rapid decrease in the rate of smoking exposure risk compared to other countries. On the other hand, lower MICs (e.g., Viet Nam) had a rapid increase in rates of alcohol exposure risk.[67]

The discrepancy in the trend in alcohol consumption between HICs and MICs in the Western Pacific region may be due to the differences in their public health policies. HICs such as Japan already have concrete policies regulating smoking and alcohol use for NCD prevention. For example, according to the Health Japan 21 national report, the prevalence of habitual drinking in Japan between 1995 and 2019 decreased from 52.7% to 27.1%.[62] Meanwhile, economic growth in MICs has made alcoholic beverages more affordable for their residents. Additionally, lower tax rates and the absence of restrictions on alcohol advertisements in the media contribute to its higher availability and use.[67] Anthey and colleagues analyzed alcohol consumption data from the WHO and suggested that per-capita consumption of alcohol was expected to increase further in the Western Pacific region and might double from 2017 to 2030.[68] Although the wealth of a country is associated with higher alcohol consumption, in some areas the Islamic religion plays a more dominant role in mitigating use due to its prohibition of alcohol.[68] For example, in Malaysia, alcohol consumption was low despite of their relatively high gross domestic product per capita.[69]

National guidelines and policies on NCD prevention and control in the Western Pacific region

National dietary and other lifestyle guidelines

National dietary guidelines are important to help promote a healthy diet and for NCD prevention and control. Selected countries in the Western Pacific region have released their national dietary guidelines; some of them might have adapted the guidelines or some items on them from the WHO/Food and Agriculture Organization (FAO). Table 3 summarizes key contents of national dietary and other lifestyle guidelines from Australia, China, Japan, the Republic of Korea, and Viet Nam for NCD prevention and control in comparison with those from the WHO/FAO. We have highlighted these countries with a representation of population size, socioeconomic development levels, geographic location, and ethnic groups.

Most of the specific guidelines for food groups and nutrients are similar across countries in the Western Pacific region. These guidelines emphasize the importance of a varied and balanced diet, moderate consumption of meat and its derivatives, and limited consumption of food rich in fat, free sugars, salt, or alcohol. It is also recommended to maintain healthy body weight, engage in regular physical activity, and avoid smoking.

Regarding intakes of macro-nutrients, the suggested proportion of energy from carbohydrates, fats, and protein was 55–75%, 10–15%, and 15–30%, respectively.[56,64–66] The selected national guidelines suggested a percentage of total fat contribution to total energy intake of <30%, except for Australia's suggestion of <35%.[77,78,81–84,91] The slight differences between Australia and the other selected four countries may be attributed to their respective traditional dietary culture. For example, the traditional Chinese diet is high in fish rather than meat and its product, while the Australian diet gains a significantly higher percentage of energy from fat, which was similar to the US (carbohydrate, 45–65%; fat, 20–35%).[92] These countries recommended saturated fats intake of <10% of total energy, which is consistent with recommendations in other countries in Europe or America.[93] Added sugar is <10% of total energy in China and the Republic of Korea,[78,81] consistent with recommendations of the US and Sweden.[93] Otherwise, the recommendation for free sugars (which could be added or naturally occurring in foods or drinks) is <10–20% for the Republic of Korea and 16–20% for Viet Nam,[81,88] which exceeds the WHO guideline recommendation of 10%. Australia and Japan did not provide specific recommendations regarding free or added sugar.[82,84] Fiber intake at >25 g/day was the same as recommendations by the WHO/FAO and was recommended by most studied countries[78,81,85,91] except Japan (males: ≥21 g/day, females: ≥18 g/day).[82]

Regarding sodium intake, China and Viet Nam recommended an intake of <2000 mg/day,[78,91] the same as

	WHO/FAO[70–76]	China[50,77,78]	Republic of Korea[79–81]	Japan[82,83]	Australia[84–87]	Viet Nam[88–90]
1) Overall guidelines for NCD prevention and control	1) Maintain a healthy body weight 2) Eat a variety of foods/ maintain a balanced diet 3) Be physically active 4) Limit salt, total and saturated fats, added sugar, and alcohol 5) Eat fruits, vegetables, legumes, nuts, and whole grains every day	1) Eat a variety of foods 2) Be active to maintain a healthy body weight 3) Eat plenty of vegetables, fruits, dairy products, whole grains, and soybeans 4) Eat moderate amounts of fish, poultry, eggs, and lean meats 5) Limit salt, cooking oil, added sugar, and alcohol	1) Maintain a healthy weight 2) Eat a balanced diet 3) Eat a variety of vegetables, fruits, whole grains, legumes 4) Replace foods high in saturated and trans fatty acids with foods high in unsaturated fatty acids 5) Limit salt, cooking oil, added sugar, and alcohol	1) Maintain the proper weight with adequate exercise and well-balanced meals 2) Avoid too much salt 3) Preserve local dishes	1) Achieve and maintain a healthy weight 2) Eat a variety of foods every day (five food groups) 3) Limit saturated fat, added salt, sugar, and alcohol 4) Increase breastfeeding	1) Reduce the double burden of malnutrition 2) Maintain energy balance, reduce overweight and obesity 3) Maintain a balanced diet 4) Reduce salt consumption 5) Be physically active 6) Reduce alcohol consumption 7) Reduce stunting
2) Macronutrients (% of total energy intake)						
Carbohydrate	55–75	50–65	55–65	50–65	45–65	55–65
Protein	10–15	10–15	7–20	13–20	15–25	13–20
Fat	15–30	20–30	15–30	20–30	20–35	20–25
Free sugar	<10	–	10–20	–	–	16–20
Added sugar	–	<10	<10	–	–	Reduced
Saturated fat	<10	<10	<7	<7	<10	<10
Trans fat	<1	<1	<1	–	–	–
Linoleic acid	–	–	–	–	4–10	1
3) Fibers						
Male (g/day)	>25	Overall 25–35	19–64 years: 30 ≥65 years: 25	18–64 years: ≥21 ≥65 years: ≥20	30	28
Female (g/day)			≥19 years: 20	18–64 years: ≥18 ≥65 years: ≥17	25	25
4) Minerals						
Sodium (mg/day)	<2000	<2000	≤2300	Male: <3000 Female: <2600	≤2300	<2000
Potassium (mg/day)	>3510	2000	>3500	Male: ≥3000 Female: ≥2600	Male: 3800 Female: 2800	>3510
5) Physical activities	1) 150–300 min of moderate-intensity aerobic physical activity; or at least 75–150 min of vigorous-intensity aerobic physical activity 2) Do muscle-strengthening activities	1) ≥150 min of moderate-intensity physical activity per week 2) Engage in physical activity actively by taking 6000 steps 3) Do muscle-strengthening activities	≥30 min a day, ≥5 times a week, walking or exercising until sweaty	1) ≥3 METs physical activity for 60 min per day for 18–64 years 2) ≥3 METs exercise for 60 min per week 3) Plus 10 min of physical activity per day	1) 2.5–5 h of moderate intensity or 1.25–2.5 h of vigorous intensity physical activity 2) Do muscle-strengthening activities	1) 150–300 min of moderate-intensity aerobic physical activity; or at least 75–150 min of vigorous-intensity aerobic physical activity 2) Do muscle-strengthening activities
6) Alcohol drinking	Limit alcohol consumption	Daily alcohol consumption should not exceed 15 g	Avoid even drinking one or two drinks a day	<40 g per day for men and <20 per day for women	No more than 100 g/week and no more than 40 g on any one day	Not recommended
7) Smoking	1) No smoking 2) Avoid secondhand-smoking	1) No smoking 2) Avoid secondhand-smoking	1) No smoking 2) Avoid secondhand-smoking	1) No smoking 2) Avoid secondhand-smoking	1) No smoking 2) Avoid secondhand-smoking	1) No smoking 2) Avoid secondhand-smoking

Table 3: **National guidelines relevant to non-communicable diseases prevention and control in selected countries in the Western Pacific region.**

that from the WHO/FAO recommendation.[70,71] This recommendation is also adopted by most countries in America and Europe,[93] while the Republic of Korea and Australia recommended ≤2300 mg/day,[81] and Japan recommended <3000 mg/day for males and <2600 mg/day for females.[82] One possible reason for this could be their traditional seasonings that typically added salt to the diet. For example, the Japanese diet is high in soy sauce, miso, and dried fish products,[94] and the Korean diet are high in kimchi and processed food.[95] The Republic of Korea and Viet Nam recommended a potassium intake of 3500 mg/day,[81,91] just as the WHO recommendation,[72] whereas it was lower in China (2000 mg/day), Japan (≥2600 mg/day),[78,82] and Australia for females (2800 mg/day) but higher in Australia for males (3800 mg/day).[84,85]

The guidelines for other lifestyle factors are generally consistent, except for alcohol consumption.[73,74,86,87,89,90] Japan and Australia recommended higher levels compared to those recommended by the WHO.

National policies and actions

Some Western Pacific region countries face an increased double burden of nutritional health problems (i.e., under- and over-nutrition problems, as marked by the prevalence of both underweight and obesity). Most MICs (e.g., China, Malaysia, and Viet Nam) were previously geared toward fighting widespread undernutrition and now need to curb the rapid increase in obesity prevalence.[96] Since 2004, the WHO Regional Office for Western Pacific region has hosted about 30 food and nutrition-centered meetings, consultations, and workshops. Since 2012, the meeting focus has been shifting from a single nutrition risk toward solution-oriented meetings directed at NCDs.[97] Countries in the Western Pacific region have responded differently to such efforts and to those by the WHO that call on actions to fight NCDs. In general, HICs have more resources and attention to give to NCD prevention and control, and thus respond better to NCDs than MICs.

Economic development creates an economic disparity in society, leaving hunger and malnutrition among the poor unresolved while increasing obesity and NCDs due to overnutrition among the wealthy, resulting in increased medical costs.[96,97] In the process of national economic development, advances in food processing technology and the increase in imported foods have made energy-dense foods with high sugar and fat content available at low prices, as a consequence of which obesity is emerging as a serious public health concern among lower MICs. National nutrition action plans play an essential role in helping to improve both national and global health and reducing health disparities.

Well-established nutrition policies and programs are important tools to guide nations in handling NCD issues and providing a framework for the coordinated implementation of interventions by governments and other organizations. For example, actively responding to its challenges, the Chinese government has released a series of national plans or actions during the past five years, such as the Healthy China 2030 Blueprint, Healthy China Initiative (2019–2030), and National Nutrition Plan (2017–2030). In the context of the comprehensive implementation of the National Strategy for Healthy China[98–100] in recent years, "National Nutrition Week" is held every year by the Chinese Nutrition Society and is supported by the Chinese government.[101] In Australia, several strategies were also employed to improve nutrition and health, including government-led voluntary nutrient reformulation targets, interpretive front-of-pack labeling, and institutional nutrition policies.[102–104] In the future, countries in the Western Pacific region may learn from the experiences of their more economically developed peers in the region, such as Japan, the Republic of Korea, and Singapore, and adapt some of the effective practices.

Key challenges

Western Pacific region countries have been undergoing rapid changes, such as demographic shifts, new approaches to disease prevention, control, and treatment, technological innovation, and economic growth, all of which affect their NCD burden as well as their related policies and actions.[1] These dynamics call for setting up strong national action strategies and policies to accelerate progress toward the global NCD targets. Therefore, proposing recommendations that encompass all Western Pacific region countries is a big challenge.

We tried to make recommendations based on the previously analyzed data and references. However, the cohort studies mainly focused on only four countries, and there were very few cohort studies on added sugar and alcoholic beverages. Quantitative analysis such as meta-analysis could not be performed due to inadequate results. There were limited representative RCTs examining the effects of lifestyle factors on NCDs. This knowledge gap hampered our ability to draw definitive conclusions and provide evidence-based recommendations for preventive strategies and interventions.

In addition, there is a need for comprehensive mHealth intervention studies targeting dietary and other lifestyle factors. It is particularly important to prioritize studies conducted in lower MICs. Policies concerning restrictions on added sugars and processed products need to be strengthened, as the consumption was increasing in the Western Pacific region. Finally, it is necessary to develop effective dietary and lifestyle strategies and programs that fit the traditional cultures in the region.

Recommendations for future actions

We proposed recommendations for action strategies for NCD prevention and control regarding dietary intakes

and other lifestyle factors in the Western Pacific region (Table 4).

Regularly eating a variety of fresh and nutritious foods such as fruits, vegetables, legumes, nuts, beans, whole grains, and fish is essential for NCD prevention and control.[70,75] Therefore, while most countries in the Western Pacific region recommended a balanced diet with a variety of food, some foods might be difficult to access due to production, geographical, political, and economic reasons. Appropriate national policies and investment in the food system are needed to improve local food production, policies, and exchange within and among countries in the Western Pacific region and beyond. However, increased trade in foodstuffs can increase pollution, requiring investments in green transportation, storage, and distribution infrastructure to improve access to fresh and nutritious foods.[105]

The DASH diet, Mediterranean dietary pattern, and vegetable and whole grain dietary pattern lower the risk of NCDs.[7–18] Moreover, increased whole grain intake was associated with decreased NCDs, but the intake of such nutritious foods in the Western Pacific region is decreasing.[75] While the availability and access to low-priced, ultra-processed, and energy-dense foods, including refined grains, are increasing as the result of rapid industrialization and globalization as well as national policies and standards that have prioritized safety over nutritional values and health promotion.[106] National policies should promote the consumption of whole grains.

Policies regulating foods high in fat, sugar, and salt should be enforced with cross-sectorial cooperation.[105] Policies such as imposing taxes, improving incentives, and industry regulations such as creating regulatory measures on food composition and labeling should be strongly considered. Therefore, future interventions need to focus on the implementation of the WHO best buys and WHO guidelines for improving the food environment.

As limiting salt intake is the most cost-effective measure to prevent and control NCDs,[71] Western Pacific region countries need to encourage the reformulation of food products to contain less salt and promote front-of-pack labeling.

Although limiting the consumption of sugar-added foods and drinks is a strong recommendation from the WHO for managing NCDs, the recommendations in some countries in the Western Pacific region are insufficient.[76,82–85,88] SSBs need to be restricted through strong government policies such as applying taxes and banning advertising, promotion, and sponsorship on TV, radio, and in print materials. In addition, school education and media campaigns should include reducing the consumption of SSBs.

Perspectives	Description
1. Overall	**1.1 Establish comprehensive approaches with new perspectives** • Changes in the way of thinking about satisfying new needs reflecting aging and socio-economic characteristics • Comprehensive management of the whole spectrum of prevention, treatment, care, screening, and monitoring of NCDs **1.2 Promote cross-sector cooperation** • Building cross-sectoral partnerships, including the healthcare sector, government sectors, health-related associations, international organizations, and companies • Strong intervention through compensation and regulations according to the degree of cooperation **1.3 Establish innovative policies and programs that enable tailored approaches** • Use of Internet of Medical Things (IoMT) and wearable devices • Providing new effective technologies to the underprivileged groups so that the digital gap does not widen
2. Promote healthy diet	**2.1 Scaling up interventions, including national investment and policy approaches to promote healthy diet** • Multidisciplinary interventions to ensure a balanced diet • Investing in green transport, storage, and distribution infrastructure for easy access to fresh, nutritious foods • Educating on a balanced diet through school, campaigns, and social media **2.2 Enhance regulations of the food industry** • Taxing the food industry high in fat, sugar, and salt, providing incentives for improvements • Front-of-pack labeling regulations and production restrictions for foods high in fat, sugar, and salt • Regulating the commercial and public availability of sugary sweetened beverages (SSB), banning SSB advertising and promotion **2.3. Establish evidence-based recommendations that reflect national and religious characteristics for evidence-based implementation** • Release energy and nutrient intake standards considering country-specific characteristics and religion, nutritional status, and disease prevalence • Establish public policies at the government level so that people in vulnerable groups can consume adequate nutrition
3. Reduce smoking and alcohol consumption	**Reduce smoking and alcohol consumption** • Increasing tax on tobacco consumption, restrictions on tobacco production licenses, and implementing packaging with large health warning graphics • Eliminating exposure to secondhand smoke in all places • Regulation of commercial and public availability of alcohol, restriction of alcohol advertising and promotions, and taxation on alcoholic beverages
4. Increase physical activity	**Invest in facilities and environments that help increase physical activity** • Investing in facilities to increase physical activity in daily life • Using wearable devices to record and encourage physical activity

Table 4: **Recommendations of action strategies to address dietary and other lifestyle factors for non-communicable diseases (NCDs) prevention and control in the Western Pacific region.**

Best practices should also eliminate industrial trans fats (i.e., ban their production, distribution, and use), limit high-fat food production, reduce fried food consumption, and limit the use of fat and oil in cooking. In terms of food production, we recommend a mandatory national limit of 2 g of industrial trans fats per 100 g of total fat in all foods and a ban on the production or use of partially hydrogenated oils, which are a major source of industrially produced trans fats, as an ingredient in foods.

For evidence-based policy implementation for NCD prevention and control, appropriate national standards for nutrient intake requirements are needed. In some Western Pacific region countries, overweight and obesity coexist with underweight and micronutrient deficiencies.[70] Therefore, national dietary guidelines should inform the public not only of the appropriate calorie intake levels to maintain healthy body weight but also of nutrient intake levels for maintaining health. Additionally, within the Western Pacific region, some religions require specific dietary rules to be followed (i.e., Halal for Muslim populations), so special attention to ethnic religions, and traditional culture should be given to national nutrition action/plans.

Given smoking rate and alcohol consumption in the Western Pacific region are higher than those at the global level, stronger national policies (i.e., the tobacco plain package policy in Australia) and actions are needed to regulate the marketing and consumption of tobacco and alcohol. In addition, investments related to comprehensive mHealth care using wearable devices are needed to encourage dietary habits and exercise in daily life, especially in lower MICs.[46,47] Finally, accompanied by socioeconomic changes, other important factors such as sleep habits have become important factors to NCDs. Further studies are needed to incorporate them, especially representative RCTs.

Finally, comprehensively managing all areas of NCD prevention and management at the national level through a new perspective on health care, especially including dietary factors and lifestyle approaches, is required. To prevent economic inequality from being applied, it is necessary to establish policies that seek ways to provide new technologies and services such as big data, artificial intelligence, and mobile health management to underprivileged groups.

Conclusions

Western Pacific region countries have experienced different shifts in dietary intakes, other lifestyle factors, and NCD burden during the past 30 years. This region has diverse cultures, religions, political systems, socioeconomic development levels, lifestyles, and environmental factors. The Western Pacific region saw some improvement and worsening of dietary intakes such as decreased consumption of sodium and saturated and trans fats and increased consumption of processed foods and sugar-sweetened beverages. Although the smoking rate in some countries has declined, the rate remains high in some countries. The prevalence of inadequate physical activity and excessive alcohol consumption has increased in many countries. There are variations in national policies and approaches targeting NCD in the Western Pacific region. More vigorous efforts are needed to develop effective and sustainable policies and programs to fight the growing NCD epidemic in this region.

Contributors

YW, HL, and XS initiated the concepts; XS, DKY, TTN, KT, KS, and HL collected data; DKY, XS, JS, and LZ analyzed the data and produced figures; and XS, DKY, KS, HL, and YW drafted the manuscript. All authors interpreted the data, revised the manuscript critically, and approved the submission of the manuscript in its current form.

Declaration of interests

There is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2023.100842.

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