

Preplanned Studies

Occurrence and Dietary Exposure of Legacy and Emerging Per- and Polyfluoroalkyl Substances in Preprepared Meat and Aquatic Dishes — China, 2025

Dan Huang^{1,2}; Yuxin Wang²; Jing Zhan³; Jiaying Liu³; Xuan Wang²; Jingguang Li^{1,2,*}; Yongning Wu^{1,2}

Summary

What is already known about this topic?

The increasing consumption of preprepared dishes in China has raised public health concerns regarding potential exposure to per- and polyfluoroalkyl substances (PFASs).

What is added by this report?

Trifluoroacetic acid was the predominant PFAS in all samples, while long-chain PFASs were mainly detected in aquatic foods. A conservative scenario-based dietary exposure assessment showed that the estimated daily intake of total PFASs ranged from 1.14 to 98.63 ng/kg body weight/day across various preprepared dishes.

What are the implications for public health practice?

Current PFASs exposure from preprepared meat and aquatic dishes poses a low health risk for consumers, but continued monitoring and risk assessment remain necessary.

ABSTRACT

Introduction: Per- and polyfluoroalkyl substances (PFASs) are widely found in household diets. With the increasing consumption of preprepared dishes in China, these products may represent an additional dietary source of PFASs.

Methods: The occurrence of PFASs in typical preprepared meat and aquatic dishes available on the Chinese market was investigated, and a conservative scenario-based dietary exposure assessment for Chinese adult males was conducted.

Results: PFASs were widely detected in the preprepared dishes, with trifluoroacetic acid (TFA) (100%), trifluoromethanesulfonate (88.41%), perfluorooctanoic acid (PFOA) (86.96%), and perfluorobutanoic acid (81.16%) showing the highest detection frequencies. The PFAS concentrations and compositional profiles varied across food categories.

The estimated daily intake (EDI) of total PFASs ranged from 1.14 to 98.63 ng/kg body weight (bw)/day, with TFA being the predominant contributor across all food samples, with an average contribution of 96.54%.

Conclusion: The consumption of preprepared meat and aquatic dishes may contribute to dietary exposure of PFAS. Although the average EDIs for PFASs were below the corresponding health-based guidance values, the common occurrence and variability of PFAS levels in these dishes highlight the need for continued monitoring of PFASs in preprepare dishes.

Per- and polyfluoroalkyl substances (PFASs) are a class of fluorinated chemicals containing at least one fully fluorinated methyl or methylene carbon (1). The environmental persistence, bioaccumulation in humans, and potential adverse health effects of PFASs have raised significant concerns (2). The diet of the general population is a major source of PFAS exposure as these compounds can accumulate along food chains and enter foods through industrial processing or migration from food-contact materials (2). In response to these concerns, the European Food Safety Authority (EFSA) established a tolerable weekly intake for the combined intake of PFASs, including perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), and perfluorohexane sulfonic acid (PFHxS) (3). Notably, owing to the widespread environmental occurrence of trifluoroacetic acid (TFA) and the increasing evidence of its adverse health effects, TFA has been officially classified as a reproductive toxicity, class 1B, by the German Environment Agency (UBA) and the German Federal Institute for Risk Assessment (4). Furthermore, the UBA established a tolerable daily intake (TDI) for TFA in 2020 (5), while EFSA is currently reviewing a health-based guidance value (HBGV) for this

compound. PFAS contamination of Chinese daily household diets and the associated dietary exposure have been extensively investigated through the China Total Diet Study (TDS) (6–7). However, the consumption of preprepared dishes has increased rapidly in recent years, becoming an increasingly common component of the daily diet, particularly among urban residents (8). Unlike traditional cooked foods, preprepared dishes are complex food matrices involving multiple stages of production, processing, packaging, storage, and consumption, all of which may influence the occurrence of PFAS in foods. Additionally, correlations between plasma PFAS levels and the consumption of packaged foods have been reported (9). However, data on PFAS contamination in preprepared dishes remain scarce, thereby limiting comprehensive assessments of dietary exposure and potential health risks to the general population.

Before sampling, a market-oriented survey was conducted across 12 provincial-level administrative divisions with well-developed preprepared dish industries to characterize the major food categories, representative brands, and sales volumes. Based on the predominant types of preprepared dishes and the market share for the consumption of residents in China, 69 retail preprepared dish samples were collected in 2025 through online and offline purchases. These samples represented 19 product subcategories and 40 brands. Meat ($n=51$) and aquatic foods ($n=18$) were prioritized because they represent the predominant food categories for preprepared dishes in China. [Supplementary Table S1](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>) lists the detailed sample information. This study analyzed 32 PFASs in all food samples, including 13 perfluoroalkyl carboxylic acids (C2–C14 PFCAs), ten perfluoroalkyl sulfonic acids (C1–C10 PFSA), three alternatives [9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (6:2 Cl-PFESA), 11-chloroeicosafluoro-3-oxaundecane-1-sulfonate, and dodecafluoro-3H-4,8-dioxanonanoate], three polyfluoroalkyl phosphate diesters (6:2, 6:2/8:2, 8:2 diPAPs), and three polyfluoroalkyl phosphinic acids (6:6, 6:8, 8:8 PFPiAs). Details of the sample pretreatment and instrumental analysis are described in our previous study (7). [Supplementary Table S2](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>) lists the spiked relative recoveries and method detection limit (MDL). For compounds with detection frequencies (DFs) exceeding 50% within a given food category, the non-

detected sample concentrations were set to 1/2 MDL. Because authoritative consumption data specific to preprepared dishes is limited, a conservative scenario-based dietary exposure assessment was conducted using the average daily household food consumption data from the Sixth China TDS to assess the possible estimated daily intake (EDI) of PFASs associated with preprepared dishes in typical Chinese adult males (≥ 18 years, average bw of 69.6 kg) (10). [Supplementary Material](https://weekly.chinacdc.cn/) (available at <https://weekly.chinacdc.cn/>) details the exposure assessment model. Statistical analyses were performed using R version 4.3.3 (R Studio, open source, Boston, MA, USA) and figures were generated using OriginPro 2022 (OriginLab, Northampton, MA, USA).

Overall, 19 of the 32 PFASs were detected in the preprepared dishes, with the total PFAS concentration ranging from 2.41 to 80.24 ng/g wet weight (ww). TFA, trifluoromethanesulfonate (TFMS), PFOA, and perfluorobutanoic acid (PFBA) were the most frequently detected PFASs across all food samples, with DFs of 100%, 88.41%, 86.96%, and 81.16%, respectively. [Table 1](#) summarizes the DFs and PFAS concentrations in the two food categories. Among the most prevalent PFASs, the median concentrations of TFA, PFBA, TFMS, and PFOA across all the preprepared dishes were 10.55, 0.054, 0.037, and 0.018 ng/g ww, respectively. The TFA and PFBA concentrations were significantly higher in meats than in aquatic foods (median: 10.91 versus 6.41 ng/g ww for TFA; 0.07 versus 0.02 ng/g ww for PFBA, $P<0.05$), whereas aquatic foods exhibited significantly higher PFOA concentrations (median: 0.05 versus 0.02 ng/g ww, $P<0.05$) ([Figure 1](#)). Consistent with this trend, long-chain PFASs (carbon chain length ≥ 6) also exhibited higher DFs and concentrations in aquatic foods than in meats ([Table 1](#)), with an average DF of 39.29% versus 10.08% and a median summed long-chain PFAS concentration of 0.16 ng/g ww versus 0.02 ng/g ww, respectively. In the conservative scenario-based estimation, the EDI was calculated for each sample and summarized as the mean to represent average exposure ([Table 2](#)). The average EDIs of the total PFAS from the preprepared meat and aquatic dishes were 17.93 and 4.38 ng/kg bw/day, respectively. As the predominant PFAS detected across all samples, the average EDIs of TFA from the preprepared meat and aquatic dishes were 17.69 and 4.02 ng/kg bw/day, respectively.

TABLE 1. DFs and concentrations of PFASs in retail preprepared meat and aquatic dishes — China, 2025.

Parameters	Meats (n=51)			Aquatic foods (n=18)		
	DF (%)	Median (25th, 75th) (ng/g ww)	Range (ng/g ww)	DF (%)	Median (25th, 75th) (ng/g ww)	Range (ng/g ww)
TFA	100.00	10.91 (7.39–16.9)	2.32–80.07	100.00	6.41 (4.36–11.50)	2.73–55.12
TFMS	98.04	0.04 (0.01–0.09)	ND–1.18	61.11	0.04 (0–0.18)	ND–0.26
PFPrA	5.88	0 (0–0)	ND–0.11	0	–	–
PFBA	92.16	0.07 (0.04–0.10)	ND–0.32	50.00	0.02 (0–0.05)	ND–0.09
PFBS	50.98	0 (0–0.01)	ND–0.02	50.00	0 (0–0.01)	ND–0.02
PFPeA	1.96	0 (0–0)	ND–0.25	0	–	–
PFHxA	13.73	0 (0–0)	ND–0.07	33.33	0 (0–0.01)	ND–0.05
PFHxS	1.96	0 (0–0)	ND–0.01	33.33	0 (0–0.01)	ND–0.09
PFHpS	0.00	–	–	22.22	0 (0–0)	ND–0.02
PFOA	84.31	0.02 (0.01–0.03)	ND–0.09	94.44	0.05 (0.02–0.06)	ND–0.46
PFOS	19.61	0 (0–0)	ND–0.09	72.22	0.04 (0–0.15)	ND–1.76
PFNA	3.92	0 (0–0)	ND–0.01	44.44	0 (0–0.02)	ND–0.32
PFDA	0.00	–	–	66.67	0.01 (0–0.05)	ND–0.17
PFUdA	3.92	0 (0–0)	ND–0.05	61.11	0.03 (0–0.08)	ND–1.23
PFDoA	3.92	0 (0–0)	ND–0.01	33.33	0 (0–0.04)	ND–0.25
PFTTrDA	1.96	0 (0–0)	ND–0.10	22.22	0 (0–0)	ND–1.16
PFTeDA	5.88	0 (0–0)	ND–0.33	5.56	0 (0–0)	ND–0.05
6:2 Cl-PFESA	0.00	–	–	55.56	0 (0–0.01)	ND–0.07
6:2 diPAP	1.96	0 (0–0)	ND–0.02	5.56	0 (0–0)	ND–0.01

Note: “–” indicates non-detected PFAS in this food category.

Abbreviation: PFASs=per- and polyfluoroalkyl substances; DF=detection frequency; ww=wet weight; ND=non-detected; IQR=interquartile range; TFA=trifluoroacetic acid; TFMS=trifluoromethanesulfonate; PFPrA=perfluoropropanoic acid; PFBA=perfluorobutanoic acid; PFBS=perfluorobutanesulfonic acid; PFPeA=perfluoropentanoic acid; PFHxA=perfluorohexanoic acid; PFHxS=perfluorohexanesulfonic acid; PFHpS=perfluoroheptanesulfonic acid; PFOA=perfluorooctanoic acid; PFOS=perfluorooctanesulfonic acid; PFNA=perfluorononanoic acid; PFDA=perfluorodecanoic acid; PFUdA=perfluoroundecanoic acid; PFDoA=perfluorododecanoic acid; PFTTrDA=perfluorotridecanoic acid; PFTeDA=perfluorotetradecanoic acid; 6:2 Cl-PFESA=9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid; 6:2 diPAP=6:2 fluorotelomer phosphate diester.

DISCUSSION

TFA is a highly persistent and mobile substance that is present at elevated levels in the environment worldwide, posing an increasing public health concern (11). In this study, TFA was the only PFAS analog detected in all preprepared dishes and was also the most abundant substance, with concentrations ranging from 2.32 to 80.07 ng/g ww, accounting for 48.78%–99.79% (mean: 96.54%) of the total PFASs mass concentration. This finding is consistent with our previous results from the Sixth China TDS, in which TFA was identified as the predominant PFAS in daily household diets, contributing more than 83% on average (7). The widespread occurrence of TFA may be attributed to its direct industrial application, formation as a degradation product of precursor chemicals, and strong persistence and high mobility, which collectively promote its broad distribution across environmental

media (11). Notably, the TFA levels in both the preprepared meat (median: 10.91 ng/g ww) and aquatic dishes (median: 6.41 ng/g ww) were higher than those previously reported for the corresponding food categories in the Sixth China TDS, where the median concentrations were 4.99 and 5.53 ng/g ww, respectively (7). This difference may be partly explained by the complex matrices of the preprepared dishes, which may include contributions from plant-origin foods, other additives, and processing steps. Furthermore, the higher DFs and concentrations of long-chain PFASs in the aquatic preprepared dishes observed in this study were consistent with our previous findings (6). The chain-length-dependent pattern corresponds with the greater bioaccumulation and biomagnification potential of long-chain PFASs within aquatic food webs (12).

Based on the conservative scenario-based estimation, the EDI of the total PFASs ranged from 1.14 to 98.63

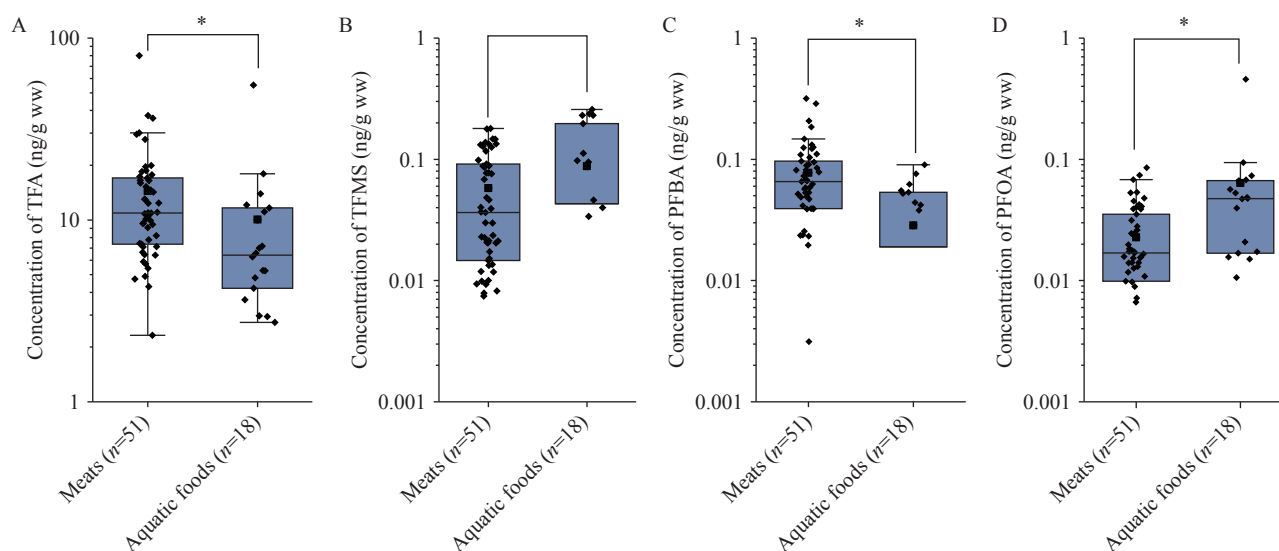


FIGURE 1. Concentrations of frequently detected PFASs in preprepared meat and aquatic dishes — China, 2025. (A) TFA; (B) TFMS; (C) PFBA and (D) PFOA.

Note: Boxes show concentrations of PFASs with DFs exceeding 50%. Differences between meat and aquatic foods were assessed using the Wilcoxon rank-sum test.

Abbreviation: TFA=trifluoroacetic acid; TFMS=trifluoromethanesulfonate; PFBA=perfluorobutanoic acid; PFOA=perfluorooctanoic acid

* indicates $P < 0.05$.

ng/kg bw/day across all dishes. TFA was the predominant contributor to overall PFAS exposure because of its relatively high concentrations in these dishes, with the EDI ranging from 1.10 to 98.42 ng/kg bw/day. Consistent with the concentration pattern, the contribution of TFA to total PFAS exposure differed by food category, accounting for an average of 98.13% in meat but a lower proportion of 92.04% in aquatic foods. These estimates should be interpreted as scenario-based indicators of the potential contribution of preprepared dishes to PFAS exposure because individual exposure may vary with dietary patterns and consumption frequency.

Due to the significant high EDI levels of TFA, the potential health risks were further assessed by calculating the hazard quotients (HQs), using the TDI of 18 $\mu\text{g/kg bw/day}$ established by the UBA (5). The average HQs for TFA were 0.001 and 0.0002 for the preprepared meat and aquatic dishes, respectively, indicating a generally low health risk for consumers.

The findings in this report are subject to at least two limitations. First, sampling was designed to investigate major market-oriented retail preprepared dishes, particularly meat and aquatic foods, which do not provide comprehensive estimates for all preprepared dishes. Second, owing to the lack of authoritative and nationally representative consumption data specific to preprepared dishes in China, dietary exposure was

estimated using household dietary consumption data from the Sixth China TDS as a conservative scenario-based approach. Changes in the dietary structure, individual consumption frequency, and food choices may introduce uncertainty. Future studies should conduct refined exposure assessments that explicitly incorporate individual-level consumption frequencies and portion sizes of preprepared dishes.

In conclusion, although PFASs were widely detected in preprepared meat and aquatic dishes, the preliminary risk assessment suggests low health risks of PFASs exposure from these dishes. Additionally, these findings support the monitoring of preprepared meat and aquatic dishes and the priority supervision of ultrashort-chain PFASs. Future studies should expand the coverage of dishes and PFASs and clarify contamination sources to support the risk management of preprepared dishes.

Conflicts of interest: No conflicts of interest.

Acknowledgements: Colleagues involved in the sample preparation, instrumental analysis, and data collection and processing throughout this study. Dr. Di Wu (Queen's University Belfast) for the English language editing of this manuscript.

Funding: Supported by the National Key Research and Development Program of China (grant number 2023YFF1104800), National Natural Science Foundation of China (grant number 22322612),

TABLE 2. Average EDI of PFASs from preprepared meat and aquatic dishes for typical Chinese adult males — China, 2025.

Compound	Meats (ng/kg bw/day)	Aquatic foods (ng/kg bw/day)
TFA	17.69	4.02
TFMS	0.07	0.04
PFPrA	0.01	0
PFBA	0.10	0.01
PFBS	0.01	0
PFPeA	0.01	0
PFHxA	0	0
PFHxS	0	0.01
PFHpS	0	0
PFOA	0.03	0.03
PFOS	0.01	0.12
PFNA	0	0.01
PFDA	0	0.01
PFUdA	0	0.06
PFDaA	0	0.01
PFTTrDA	0	0.04
PFTeDA	0.01	0
6:2 Cl-PFESA	0	0.01
6:2 diPAP	0	0
Total PFASs	17.93	4.38

Note: "Total PFASs" refers to the EDI of all detected PFASs.

Abbreviation: EDI=estimated daily intake; bw=body weight; TFA=trifluoroacetic acid; TFMS=trifluoromethanesulfonate; PFPrA=perfluoropropanoic acid; PFBA=perfluorobutanoic acid; PFBS=perfluorobutanesulfonic acid; PFPeA=perfluoropentanoic acid; PFHxA=perfluorohexanoic acid; PFHxS=perfluorohexanesulfonic acid; PFHpS=perfluoroheptanesulfonic acid; PFOA=perfluorooctanoic acid; PFOS=perfluorooctanesulfonic acid; PFNA=perfluorononanoic acid; PFDA=perfluorodecanoic acid; PFUdA=perfluoroundecanoic acid; PFDaA=perfluorododecanoic acid; PFTTrDA=perfluorotridecanoic acid; PFTeDA=perfluorotetradecanoic acid; 6:2 Cl-PFESA=9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid; 6:2 diPAP=6:2 fluorotelomer phosphate diester.

Young Scientists Fund of the Natural Science Foundation of China (grant number 22206032), and Taishan Scholars Project of Shandong Province and the Jinan "Twenty Measures for Universities" Program for Introducing Innovation Teams (grant number 202333027).

doi: 10.46234/ccdcw2026.119

Corresponding author: Jingguang Li, lijg@cfsa.net.cn.

¹ School of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China;

² NHC Key Lab of Food Safety Risk Assessment, Research Unit of Food Safety, Chinese Academy of Medical Sciences, Beijing, China;

³ Key Laboratory of Precision Nutrition and Food Quality, Department of Nutrition and Health, China Agricultural University, Beijing, China.

Copyright © 2026 by Chinese Center for Disease Control and Prevention & Chinese Academy of Preventive Medicine. All content is distributed under a Creative Commons Attribution Non Commercial License 4.0 (CC BY-NC).

Submitted: April 12, 2026

Accepted: June 03, 2026

Issued: June 12, 2026

REFERENCES

- Wang ZY, Buser AM, Cousins IT, Demattio S, Drost W, Johansson O, et al. A new OECD definition for per- and polyfluoroalkyl substances. *Environ Sci Technol* 2021;55(23):15575 – 8. <https://doi.org/10.1021/acs.est.1c06896>.
- Evich MG, Davis MJB, McCord JP, Acrey B, Awkerman JA, Knappe DRU, et al. Per- and polyfluoroalkyl substances in the environment. *Science* 2022;375(6580):eabg9065. <https://doi.org/10.1126/science.abg9065>.
- EFSA Panel on Contaminants in the Food Chain (EFSA CONTAM Panel), Schrenk D, Bignami M, Bodin L, Chipman JK, del Mazo J, et al. Risk to human health related to the presence of perfluoroalkyl substances in food. *EFSA J* 2020;18(9):e06223. <https://doi.org/10.2903/j.efsa.2020.6223>.
- Bundesinstitut für Risikobewertung (BfR). Trifluoressigsäure (TFA): Bewertung für Einstufung in neue Gefahrenklassen vorgelegt. 2025. <https://www.bfr.bund.de/presseinformation/trifluoressigsaeure-tfa-bewertung-fuer-einstufung-in-neue-gefahrenklassen-vorgelegt/>. [2026-04-12].
- Umweltbundesamt (UBA). Ableitung eines gesundheitlichen Leitwertes für Trifluoressigsäure (TFA). 2020. https://www.umweltbundesamt.de/system/files/medien/5620/dokumente/ableitung_gesundheitlichen_leitwertes_fuer_trifluoressigsaeure_fuer_uba-homepage-20250731.pdf. [2026-05-10].
- Wang YX, Gao XY, Liu JY, Lyu B, Li JG, Zhao YF, et al. Exposure to emerging and legacy polyfluoroalkyl substances in the sixth total diet study - China, 2016-2019. *China CDC Wkly* 2022;4(9):168 – 71. <https://doi.org/10.46234/ccdcw2022.042>.
- Huang D, Wang YX, Zhan J, Liu JY, Lyu B, Li JG, et al. Comprehensive investigation on the occurrence of ultrashort-chain PFASs in foods and their dietary exposure by a total diet study in China. *Environ Sci Technol Lett* 2026;13(3):326 – 32. <https://doi.org/10.1021/acs.estlett.5c01169>.
- Sun HH, Wei JJ, Zhu JJ, Zhu MY, Wu KG. Development status, critical challenges, and future pathways of the prepared dish industry: A systematic review. *J Wuhan Polytech Univ* 2026;1-12. <http://link.cnki-net-s.webvpn.cams.cn/urlid/42.1856.T.20260316.1248.002>. (In Chinese)
- Seshasayee SM, Rifas-Shiman SL, Chavarro JE, Carwile JL, Lin PID, Calafat AM, et al. Dietary patterns and PFAS plasma concentrations in childhood: Project Viva, USA. *Environ Int* 2021;151:106415. <https://doi.org/10.1016/j.envint.2021.106415>.
- National Health Commission of the People's Republic of China. Report on Chinese Residents' chronic diseases and nutrition (2020). Beijing: People's Medical Publishing House. 2021.
- Zhi Y, Lu XW, Munoz G, Yeung LWY, De Silva AO, Hao SL, et al. Environmental occurrence and biotic concentrations of ultrashort-chain perfluoroalkyl acids: overlooked global organofluorine contaminants. *Environ Sci Technol* 2024;58(49):21393 – 410. <https://doi.org/10.1021/acs.est.4c04453>.
- Xing YD, Zhou Y, Zhang X, Lin X, Li JY, Liu P, et al. The sources and bioaccumulation of per- and polyfluoroalkyl substances in animal-derived foods and the potential risk of dietary intake. *Sci Total Environ* 2023;905:167313. <https://doi.org/10.1016/j.scitotenv.2023.167313>.

SUPPLEMENTARY MATERIAL

SUPPLEMENTAL TEXT S1. Dietary exposure assessment model for PFASs from retail preprepared meat and aquatic dishes among typical Chinese adult males.

Dietary exposure was estimated using a scenario-based approach. For each detected PFAS, the estimated dietary intake (EDI) was calculated as follows:

$$EDI = \frac{c \times fc}{bw}$$

Where c is the PFAS concentration in preprepared dishes [ng/g, wet weight (ww)], fc is the average daily food consumption from the Sixth China Total Diet Study (TDS) to represent the corresponding preprepared dish category (meats: 85.55 g/day; aquatic foods: 27.90 g/day), and bw is the average body weight of Chinese adult males (69.6 kg). In the scenario estimation, the average daily household food consumption data for each food category from the Sixth China TDS were considered to be entirely represented by preprepared dishes of that category.

SUPPLEMENTARY TABLE S1. Sample information for retail preprepared meat and aquatic dishes — China, 2025.

Food category	Sample item	Brand	Place of production
Meats	Stewed Beef with Tomatoes-1	Brand 1	Sichuan
Meats	Stewed Beef with Tomatoes-2	Brand 2	Anhui
Meats	Stewed Beef with Tomatoes-3	Brand 3	Zhejiang
Meats	Stewed Beef with Tomatoes-4	Brand 4	Beijing
Meats	Kung Pao Chicken-1	Brand 5	Zhejiang
Meats	Kung Pao Chicken-2	Brand 6	Jiangsu
Meats	Kung Pao Chicken-3	Brand 7	Shandong
Meats	Kung Pao Chicken-4	Brand 8	Henan
Meats	Beef Tenderloin Strips with Black Pepper-1	Brand 9	Zhejiang
Meats	Beef Tenderloin Strips with Black Pepper-2	Brand 10	Hubei
Meats	Beef Tenderloin Strips with Black Pepper-3	Brand 8	Henan
Meats	Braised Pork in Brown Sauce-1	Brand 5	Zhejiang
Meats	Braised Pork in Brown Sauce-2	Brand 10	Shanghai
Meats	Braised Pork in Brown Sauce-3	Brand 1	Sichuan
Meats	Braised Pork in Brown Sauce-4	Brand 11	Shandong
Meats	Braised Pork in Brown Sauce-5	Brand 10	Shanghai
Meats	Braised Pork in Brown Sauce-6	Brand 8	Henan
Meats	Braised Pork in Brown Sauce-7	Brand 12	Guangdong
Meats	Braised Pork in Brown Sauce-8	Brand 13	Shandong
Meats	Braised Pork in Brown Sauce-9	Brand 4	Beijing
Meats	Chicken with Fish Maw-1	Brand 14	Guangdong
Meats	Chicken with Fish Maw-2	Brand 15	Guangdong
Meats	Steamed Pork Belly with Preserved Mustard Greens-1	Brand 5	Zhejiang
Meats	Steamed Pork Belly with Preserved Mustard Greens-2	Brand 1	Sichuan
Meats	Steamed Pork Belly with Preserved Mustard Greens-3	Brand 4	Beijing
Meats	Stewed Beef Brisket with Radish-1	Brand 16	Guangdong
Meats	Stewed Beef Brisket with Radish-2	Brand 17	Guangdong
Meats	Stewed Beef Brisket with Radish-3	Brand 18	Beijing
Meats	Stewed Beef Brisket with Radish-4	Brand 4	Beijing

Continued

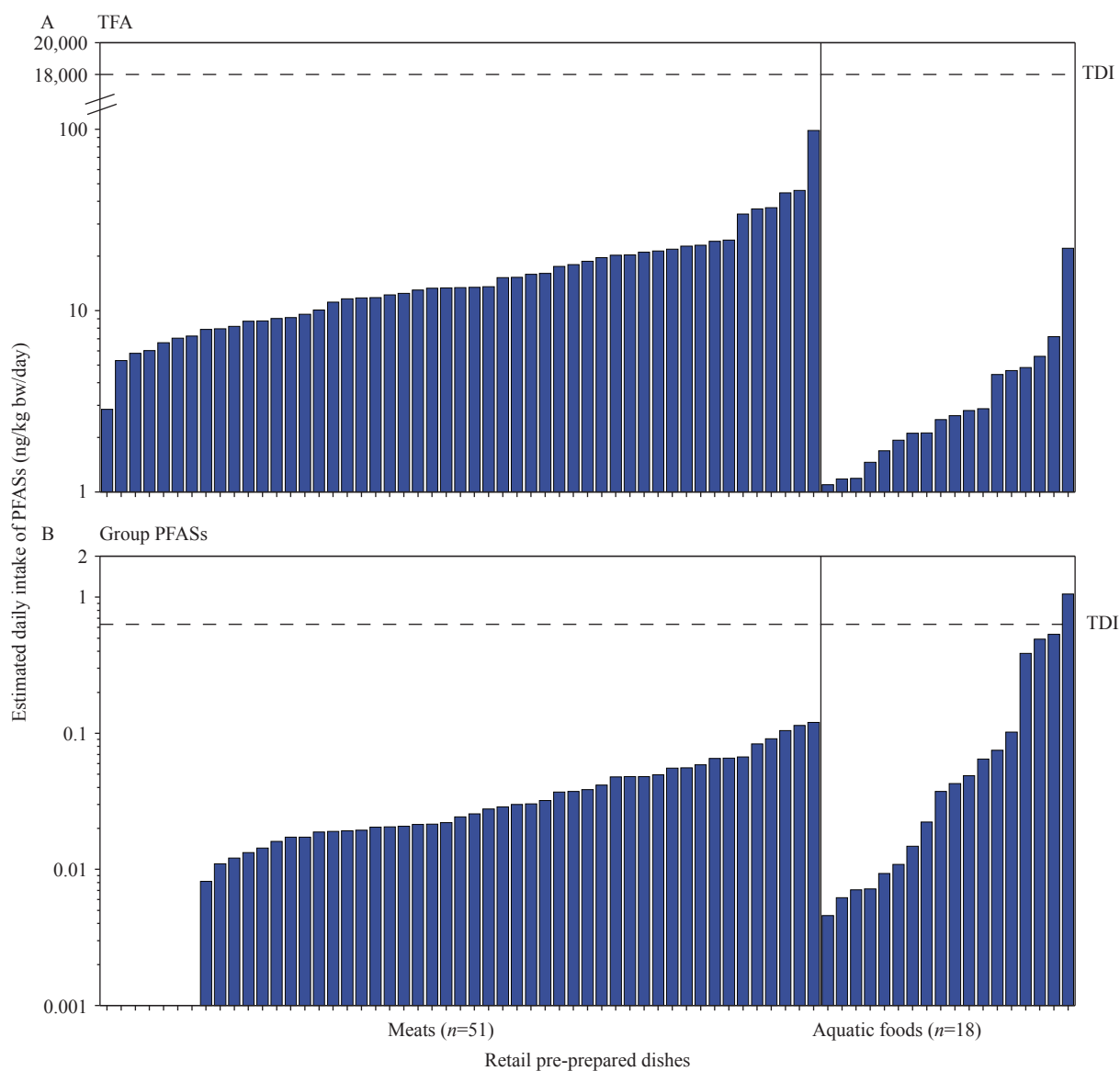
Food category	Sample item	Brand	Place of production
Meats	Three Delicacies-1	Brand 5	Zhejiang
Meats	Braised Pork Ball in Brown Sauce-1	Brand 10	Shanghai
Meats	Braised Pork Ball in Brown Sauce-2	Brand 7	Shandong
Meats	Braised Pork Ball in Brown Sauce-3	Brand 5	Zhejiang
Meats	Braised Pork Ball in Brown Sauce-4	Brand 4	Beijing
Meats	Braised Pork Balls in Gravy-1	Brand 19	Shandong
Meats	Braised Pork Balls in Gravy-2	Brand 20	Beijing
Meats	Braised Pork Balls in Gravy-3	Brand 4	Beijing
Meats	Sweet and Sour Pork Tenderloin-1	Brand 19	Shandong
Meats	Sweet and Sour Pork Tenderloin-2	Brand 21	Beijing
Meats	Sweet and Sour Pork Tenderloin-3	Brand 5	Zhejiang
Meats	Stewed Beef with Potatoes-1	Brand 22	Anhui
Meats	Stewed Beef with Potatoes-2	Brand 8	Henan
Meats	Stewed Beef with Potatoes-3	Brand 4	Beijing
Meats	Crispy Fried Pork Strips-1	Brand 23	Sichuan
Meats	Crispy Fried Pork Strips-2	Brand 6	Jiangsu
Meats	Crispy Fried Pork Strips-3	Brand 24	Sichuan
Meats	Crispy Fried Pork Strips-4	Brand 11	Shandong
Meats	Yuxiang Shredded Pork-1	Brand 25	Zhejiang
Meats	Yuxiang Shredded Pork-2	Brand 1	Sichuan
Meats	Yuxiang Shredded Pork-3	Brand 10	Shanghai
Meats	Yuxiang Shredded Pork-4	Brand 26	Tianjin
Aquatic foods	Fotiaoqiang-1	Brand 27	Shandong
Aquatic foods	Fotiaoqiang-2	Brand 28	Fujian
Aquatic foods	Fotiaoqiang-3	Brand 29	Guangdong
Aquatic foods	Fotiaoqiang-4	Brand 8	Henan
Aquatic foods	Millet Porridge with Sea Cucumber-1	Brand 30	Fujian
Aquatic foods	Millet Porridge with Sea Cucumber-2	Brand 31	Shandong
Aquatic foods	Millet Porridge with Sea Cucumber-3	Brand 32	Fujian
Aquatic foods	Braised Hairtail in Brown Sauce-1	Brand 33	Anhui
Aquatic foods	Braised Hairtail in Brown Sauce-2	Brand 2	Anhui
Aquatic foods	Braised Hairtail in Brown Sauce-3	Brand 34	Anhui
Aquatic foods	Braised Hairtail in Brown Sauce-4	Brand 35	Beijing
Aquatic foods	Fish with Pickled Mustard Greens-1	Brand 36	Zhejiang
Aquatic foods	Fish with Pickled Mustard Greens-2	Brand 6	Jiangsu
Aquatic foods	Fish with Pickled Mustard Greens-3	Brand 37	Sichuan
Aquatic foods	Fish with Pickled Mustard Greens-4	Brand 38	Jiangsu
Aquatic foods	Fish with Pickled Mustard Greens-5	Brand 39	Guangdong
Aquatic foods	Fish with Pickled Mustard Greens-6	Brand 40	Anhui
Aquatic foods	Shrimp with Mixed Beans-1	Brand 5	Zhejiang

Note: 19 items of retail preprepared meat and aquatic dishes from 40 brands across 12 provincial-level administrative divisions were collected.

SUPPLEMENTARY TABLE S2. Spiked relative recoveries (average $\pm$ relative standard deviation) and method detection limits for PFAS analysis in preprepared meat and aquatic dishes ($n=3$).

Compound	Internal standard	Meats		Aquatic foods	
		Recovery $\pm$ RSD (%)	MDL (ng/g ww)	Recovery $\pm$ RSD (%)	MDL (ng/g ww)
TFA	$^{13}\text{C}_2$ -TFA	90.86 $\pm$ 2.40	0.031	112.67 $\pm$ 0.76	0.138
TFMS	$^{13}\text{C}_3$ -PFBS	102.75 $\pm$ 1.18	0.002	128.12 $\pm$ 1.59	0.004
PFEtS	$^{13}\text{C}_3$ -PFBS	80.12 $\pm$ 4.56	0.001	112.67 $\pm$ 3.88	0.002
PFPPrA	$^{13}\text{C}_3$ -PFPPrA	84.11 $\pm$ 1.64	0.007	86.60 $\pm$ 5.68	0.002
PFPPrS	$^{13}\text{C}_3$ -PFBS	86.87 $\pm$ 1.14	0.002	133.41 $\pm$ 1.27	0.003
PFBA	$^{13}\text{C}_4$ -PFBA	95.38 $\pm$ 1.44	0.002	100.33 $\pm$ 0.52	0.008
PFBS	$^{13}\text{C}_3$ -PFBS	83.45 $\pm$ 2.08	0.002	117.77 $\pm$ 1.39	0.001
PFPeA	$^{13}\text{C}_5$ -PFPeA	91.06 $\pm$ 1.45	0.021	109.16 $\pm$ 0.30	0.010
PFPeS	$^{13}\text{C}_3$ -PFHxS	72.05 $\pm$ 1.97	0.003	100.18 $\pm$ 1.54	0.003
PFHxA	$^{13}\text{C}_5$ -PFHxA	83.54 $\pm$ 3.09	0.008	112.18 $\pm$ 0.78	0.006
PFHxS	$^{13}\text{C}_3$ -PFHxS	105.26 $\pm$ 0.78	0.004	108.37 $\pm$ 0.61	0.003
PFHpA	$^{13}\text{C}_4$ -PFHpA	87.83 $\pm$ 0.96	0.003	111.57 $\pm$ 1.71	0.007
PFHpS	$^{13}\text{C}_3$ -PFHxS	69.90 $\pm$ 2.51	0.003	106.94 $\pm$ 2.56	0.006
PFOA	$^{13}\text{C}_8$ -PFOA	90.60 $\pm$ 0.26	0.001	110.99 $\pm$ 2.10	0.004
PFOS	$^{13}\text{C}_8$ -PFOS	84.37 $\pm$ 1.17	0.016	115.25 $\pm$ 2.82	0.002
PFNA	$^{13}\text{C}_9$ -PFNA	91.58 $\pm$ 1.27	0.009	105.23 $\pm$ 1.62	0.004
PFNS	$^{13}\text{C}_8$ -PFOS	56.29 $\pm$ 3.63	0.008	96.39 $\pm$ 4.29	0.005
PFDA	$^{13}\text{C}_6$ -PFDA	89.63 $\pm$ 0.57	0.017	112.38 $\pm$ 2.49	0.004
PFDS	$^{13}\text{C}_8$ -PFOS	50.14 $\pm$ 6.28	0.011	93.71 $\pm$ 3.02	0.009
PFUdA	$^{13}\text{C}_7$ -PFUdA	93.48 $\pm$ 2.62	0.014	117.49 $\pm$ 0.26	0.009
PFDaA	$^{13}\text{C}_2$ -PFDaA	93.44 $\pm$ 5.13	0.015	115.31 $\pm$ 1.01	0.007
PFTTrDA	$^{13}\text{C}_2$ -PFTTeDA	63.34 $\pm$ 4.50	0.031	117.23 $\pm$ 8.04	0.035
PFTTeDA	$^{13}\text{C}_2$ -PFTTeDA	88.72 $\pm$ 1.05	0.008	107.03 $\pm$ 1.00	0.024
ADONA	$^{13}\text{C}_8$ -PFOA	91.42 $\pm$ 1.17	0.001	108.48 $\pm$ 2.53	0.002
6:2 Cl-PFESA	$^{13}\text{C}_8$ -PFOS	88.44 $\pm$ 0.71	0.001	106.52 $\pm$ 0.38	0.003
8:2 Cl-PFESA	$^{13}\text{C}_8$ -PFOS	54.34 $\pm$ 9.38	0.003	70.83 $\pm$ 10.47	0.005
6:6 PFPI	$^{13}\text{C}_4$ -6:2 diPAP	157.53 $\pm$ 3.79	0.007	114.08 $\pm$ 3.01	0.004
6:8 PFPI	$^{13}\text{C}_4$ -6:2 diPAP	43.81 $\pm$ 12.62	0.009	66.39 $\pm$ 12.63	0.008
8:8 PFPI	$^{13}\text{C}_4$ -8:2 diPAP	67.93 $\pm$ 14.90	0.007	177.79 $\pm$ 12.15	0.008
6:2 diPAP	$^{13}\text{C}_4$ -6:2 diPAP	92.13 $\pm$ 3.29	0.003	99.32 $\pm$ 4.41	0.008
6:2/8:2 diPAP	$^{13}\text{C}_4$ -8:2 diPAP	76.93 $\pm$ 4.87	0.003	50.61 $\pm$ 18.28	0.007
8:2 diPAP	$^{13}\text{C}_4$ -8:2 diPAP	94.34 $\pm$ 1.14	0.006	97.47 $\pm$ 3.23	0.017

Abbreviations: PFASs=per- and polyfluoroalkyl substances; RSD=relative standard deviation; MDL=method detection limit; ww=wet weight; TFA=trifluoroacetic acid; TFMS=trifluoromethanesulfonate; PFEtS=perfluoroethanesulfonate; PFPPrA=perfluoropropanoic acid; PFPPrS=perfluoro-1-propanesulfonate; PFBA=perfluorobutanoic acid; PFBS=perfluorobutanesulfonic acid; PFPeA=perfluoropentanoic acid; PFPeS=perfluoropentanesulfonic acid; PFHxA=perfluorohexanoic acid; PFHxS=perfluorohexanesulfonic acid; PFHpA=perfluoroheptanoic acid; PFHpS=perfluoroheptanesulfonic acid; PFOA=perfluorooctanoic acid; PFOS=perfluorooctanesulfonic acid; PFNA=perfluorononanoic acid; PFNS=perfluorononanesulfonic acid; PFDA=perfluorodecanoic acid; PFDS=perfluorodecanesulfonic acid; PFUdA=perfluoroundecanoic acid; PFDaA=perfluorododecanoic acid; PFTTrDA=perfluorotridecanoic acid; PFTTeDA=perfluorotetradecanoic acid; ADONA=Ammonium 4,8-dioxa-3H-perfluorononanoate; 6:2 Cl-PFESA=9-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid; 8:2 Cl-PFESA=11-chlorohexadecafluoro-3-oxanonane-1-sulfonic acid; 6:6 PFPI=6:6 perfluorophosphinic acid; 6:8 PFPI=6:8 perfluorophosphinic acid; 8:8 PFPI=8:8 perfluorophosphinic acid; 6:2 diPAP=6:2 fluorotelomer phosphate diester; 6:2/8:2 diPAP=6:2/8:2 fluorotelomer phosphate diester; 8:2 diPAP=8:2 fluorotelomer phosphate diester.



SUPPLEMENTARY FIGURE S1. Estimated daily intake (EDI) of TFA and the group PFASs from retail preprepared meat and aquatic dishes for typical Chinese adult males — China, 2025. (A) EDI of TFA compared with the tolerable daily intake (TDI) of 18 $\mu\text{g/kg bw/day}$ established by the German Environment Agency; (B) EDI of the group PFASs (PFOS, PFOA, PFNA, and PFHxS) compared with the equivalent TDI of 0.63 ng/kg bw/day , derived from the tolerable weekly intake of 4.4 ng/kg bw/week set by the European Food Safety Authority.

Note: The dashed line represents the corresponding health-based guidance value for PFASs. Braised Hairtail in Brown Sauce-4 was the only dish with an EDI exceeding this equivalent TDI.

Abbreviation: TFA=trifluoroacetic acid; PFOS=perfluorooctanesulfonic acid; PFOA=perfluorooctanoic acid; PFNA=perfluorononanoic acid; PFHxS=perfluorohexanesulfonic acid; TDI=tolerable daily intake