The Food and Microbiome Longitudinal Investigation (FAMiLI) Study: An Asian American–Enriched Multiethnic Environmental Cohort

Jiyoung Ahn[1,2], Zelle Halloran[1], Dia B. Beggs[2], Feng Wu[1], Yuxi Duan[1], Hanah Hwang[1], Ziying Zhu[1], Vicente Flores[1], Vittorio Albergamo[3], Soyoung Kwak[1,2], Sara Kim[4], Steve Mei[5], Lan N. Đoàn[2], Stella S. Yi[1,2], Huilin Li[1,2], and Richard B. Hayes[1,2]

ABSTRACT

Background: More than 90% of Asian American (AsA) adults are first- or second-generation immigrants, undergoing substantial environmental and sociocultural transitions; yet most environmental epidemiology cohorts have included few AsA participants.

Methods: The Food and Microbiome Longitudinal Investigation (FAMiLI) is an environmental health cohort enriched with AsA adults (predominantly Korean and Chinese American) and designed to capture environmental exposures, dietary acculturation, and sociocultural factors across immigration generations. Its biobank—including buccal and stool specimens—supports research on the oral and gut microbiomes, human genomics, and other multiomics.

Results: Since its launch in 2018, FAMiLI has completed baseline recruitment and biospecimen collection for 13,183 adults 40 to 75 years of age. The cohort is now expanding to include an additional 3,000 AsA adults, bringing the total to approximately 16,000 participants, with an expected distribution of ~50% AsA and ~50% from other racial/ethnic groups. This expansion provides an opportunity to examine AsA environmental health experiences within the broader US context.

Conclusions: FAMiLI is a unique national resource to address priority questions in environmental health, including microbiome and exposome science, individual susceptibility, and large-scale data analytics.

Impact: The cohort supports investigation of critical windows of environmental change across the immigration experience, racial and ethnic disparities, and drivers of emerging health outcomes, including cancer, cardiovascular disease, diabetes, and other outcomes. This cohort offers essential data to inform prevention strategies and shape public health policy to improve health outcomes in AsA communities.

Introduction

Asian Americans (AsA) are the fastest growing racial or ethnic group in the United States (1); yet, limited data exist for most health conditions in this population. Most epidemiologic cohorts have not included sufficient numbers of AsA to support investigations of etiologic factors (2, 3)—a gap recently highlighted by the National Institutes of Health (NIH; ref. 4). Because more than 63% of AsA adults are first-generation immigrants (i.e., born outside the United States) and nearly half have limited English proficiency (1), current research provides an incomplete understanding of AsA health and health disparities—particularly among AsA population groups who are low income or prefer a language other than English. Research focused on AsA is urgently needed, as many clinical and public health decisions are based on evidence generated from studies that did not adequately include AsA.

AsA are similarly underrepresented in environmental health research. Data from health examination surveys and air pollution studies indicate that AsA populations experience high risks from environmental exposures (5–7) and yet they remain understudied in research on environmental health and environmental justice. In addition, AsA first-generation immigrants—as well as subsequent generations—are undergoing substantial environmental changes and an acculturation process involving shifts in lifestyle, behaviors, and values as they adapt to a new cultural and societal context (8). The nature, magnitude, and health implications of these transitions remain poorly understood and insufficiently examined (3). Without a nuanced understanding of these processes and the impact on health outcomes, collective progress toward addressing AsA health disparities is stymied.

The Food and Microbiome Longitudinal Investigation (FAMiLI) is a large environmental epidemiologic cohort that includes AsA across the broad socioeconomic spectrum. FAMiLI uniquely captures environmental exposures, dietary acculturation, and sociocultural factors across immigration generations. Its biobank, containing buccal and stool samples, enables comprehensive biological discovery in the oral and gut microbiomes, human genomics, metabolomics, and other omics platforms. The goal of FAMiLI is to investigate environmental, sociocultural, dietary, and biological determinants of health disparities affecting AsA populations, with the aim of improving AsA health.

Materials and Methods

History and cohort population

Original recruitment and expansion (timeline)

From 2018 to 2023 (phase I), we completed recruitment and biospecimen collection for 13,183 participants, including 5,672 AsA,

[1]NYU Laura and Isaac Perlmutter Cancer Center, New York, New York. [2]Department of Population Health, NYU Grossman School of Medicine, New York, New York. [3]Human Environmental Analytical Lab (HEAL) and Department of Pediatrics, NYU Grossman School of Medicine, New York, New York. [4]Korean Community Services of Metropolitan New York, Inc., New York, New York. [5]Chinese American Planning Council (CPC) - Brooklyn Community Center, New York, New York.

Corresponding Author: Jiyoung Ahn, NYU Langone Health, NYU Perlmutter Cancer Center, 522 First Avenue, Smilow Research Building, Suite 1001C, New York, NY 10016. E-mail: Jiyoung.Ahn@nyulangone.org

Cancer Epidemiol Biomarkers Prev 2026;35:1517–26

doi: 10.1158/1055-9965.EPI-26-0178

©2026 American Association for Cancer Research

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

5,682 Whites, 671 Blacks, and 1,158 participants of other or unreported racial/ethnic groups under NCI funding (**Table 1**). Under new National Institute of Environmental Health Sciences (NIEHS) funding (phase II, 2024–2029), the cohort is expanding by 3,000 AsA adults, reaching ~16,000 participants (~50% AsA and ~50% other racial/ethnic groups), which will facilitate cross-racial comparisons. Phase II will maintain FAMiLI's existing data and biorepository while enriching the cohort through continued recruitment, longitudinal follow-up, expanded biospecimen collection, enhanced data infrastructure, and strengthened collaborations. Continuation and expansion of this cohort are critical for (i) capturing longitudinal information on immigration-related transitions, including acculturation during key windows of environmental change and (ii) prospectively identifying incident health outcomes linked to environmental, sociocultural, and biological factors.

Eligibility criteria

Participants are eligible for FAMiLI if they: i, are 40 years of age or older; ii, live in the United States; iii, do not plan to relocate internationally within the next 5 years; iv, are willing to complete periodic questionnaires; and v, have the decisional capacity to provide informed consent.

Research materials and regulatory approval

To enhance participation among diverse racial and ethnic groups, study materials are offered in English, Korean, Mandarin, and Spanish, based on participants' preferred language. All materials were translated from English into the target language by native language speakers and then reviewed by an independent second person, including community partners. Participants were supported by bilingual research assistants (English/Mandarin, English/Korean, and English/Spanish) through all touchpoints of the study. We also closely partnered with a social marketing agency, APartnership, with specialization in reaching the AsA and Hispanic market to develop a consistent look for the materials and website. All study materials and processes were approved by the New York University (NYU) Langone Health (NYULH) Institutional Review Board (IRB).

Recruitment strategies

We employed a multipronged recruitment strategy to build a large, diverse, and community-engaged FAMiLI cohort. By integrating institutional, community-based, and digital approaches, we established a broad and inclusive participant base. This strategy not only supported efficient enrollment but also fostered long-term community partnerships which strengthened trust and participation. This study includes participants from across the United States, as shown in the participant address map (**Fig. 1**). Alaska, Hawaii, and US territories are eligible; however, no participants from these regions have enrolled in the study to date. Although the cohort is not based on representative sampling, it captures a broad national population.

Electronic health record–based recruitment: Electronic health record (EHR) recruitment was conducted through the NYULH DataCore and MyChart platforms. Individuals who were identified as potentially eligible based on the eligibility criteria and having previously agreed to be contacted for research were invited through MyChart messaging. This method enabled efficient screening and enrollment, with participants able to complete registration and consent remotely while minimizing study staff workload.

Social media and online recruitment: We leveraged multiple online platforms to reach diverse communities, including culturally specific channels such as KakaoTalk (Korean) and WeChat (Chinese), as well as other platforms including ResearchMatch.org, MissyUSA (a Korean American online community), Asian and Pacific Islander Caucus for Public Health, and South Asian Public Health Association email listservs (public health and allied professionals), and the FAMiLI Study website (**Fig. 2A**). Participants could sign up directly online, and study staff processed interest forms through a REDCap-based tracking system. ResearchMatch.org was particularly effective for large-scale outreach to individuals already expressing interest in research participation.

Community-based recruitment: Community outreach served as a cornerstone of recruitment for socioeconomically diverse communities, enabling sustained engagement with first-generation individuals and those who prefer languages other than English. We established long-standing partnerships with community organizations across the New York metropolitan area. Collaborations with community health workers and organizations such as the Korean Community Services of Metropolitan New York and Chinese American Planning Council ensured ongoing referrals and community engagement. Study staff also regularly visited community centers, churches, and senior centers to distribute study kits and build rapport with both partners and community members, reinforcing trust and visibility.

Advertising and outreach: To broaden reach, we conducted print advertising in Asian-language newspapers such as *The Korean Daily* in New York, Los Angeles, Orange County, and the Washington, DC area. These efforts were supplemented by direct mailings and referral strategies. Snowball sampling further amplified recruitment, as participants (<5%) referred family members and friends who subsequently enrolled.

Table 1. FAMiLI timeline and overview.

	Phase I (2018–2023)	Phase II (2024–2029)
Goal	• Cohort establishment	• Expansion/enrichment • Environmental aspects
Recruitment	• Recruited a total of 13,183 participants (who provided demographic questionnaire and informed consent) • This includes 5,672 AsA participants	• Expand to a total of 16,000 participants • With an additional 3,000 new AsA recruits
Data and sample collection	• Baseline questionnaires completed • Stool and oral samples collected (12,500 participants provided samples) • Initiated follow-up in phase I; continuing through phase II	• New environmental measures (wristband chemical monitoring) • Enhanced geocoding/exposure data • Neighborhood and personal air quality

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

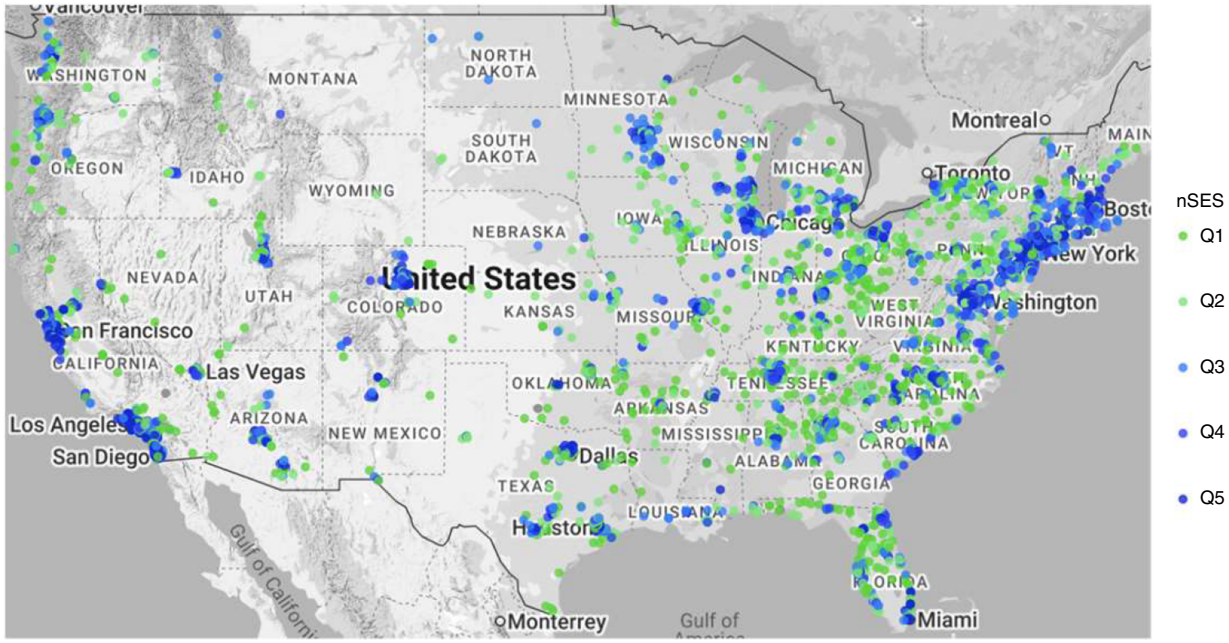


Figure 1.

FAMiLI participant addresses. Each dot represents the address of a FAMiLI participant across the United States. Shading indicates quintiles (Q) of neighborhood socioeconomic status (nSES), illustrating the diversity of SES among participants. Alaska, Hawaii, and US territories are eligible; however, no participants resided from these regions at the time of enrollment.

Enrollment and consent process

We implemented a rapid, home-based enrollment approach in which participants received mailed packages containing questionnaires and biospecimen collection kits, making participation accessible and convenient. Prior to consent, study staff completed CITI human subjects training in accordance with NYU and ethical guidelines. All participants provided written informed consent before enrollment. The study was conducted in accordance with recognized ethical guidelines, including the Declaration of Helsinki, the Council for International Organizations of Medical Sciences guidelines, the Belmont Report, and the US Common Rule, and was approved by the NYULH IRB. Written consent was obtained either online at home or in person. Participants recruited via EHRs or social media/online platforms provided consent electronically through a secure REDCap link. For those recruited through community outreach or in-person events, consent was done in person. Participants signed 2 copies of the consent form—one for their records and one for the research team. The consent form outlined the study purpose, participation requirements, and procedures for data storage and future data sharing. If a participant's preferred language is not English, the informed consent and questionnaires and study instructions are administered in their preferred language. Enrollment was considered complete once participants confirmed their eligibility, signed the informed consent, and completed the demographic questionnaire. All enrollment and consent processes were approved by the NYULH IRB.

Each participant was assigned a unique study ID, and all data were entered into a secure REDCap database. Signed consent forms were securely stored in locked cabinets. After completing informed consent, participants received study biospecimen collection kits via mail (**Fig. 2B**). Kits included a detailed instruction booklet, step-by-step directions for biospecimen sample collection, and prepaid, addressed envelopes for sample return. All participants were compensated for their time and effort via ClinCard (GreenPhire, Inc.), a reloadable prepaid debit card, once completed study kits were returned to the study center. The study was approved by the NYU IRB.

Data collection

Demographic questionnaires (9 pages) captured contact information, socioeconomic status, intrapersonal and interpersonal factors, and other key variables (**Tables 2** and **3**). Demographic data collected at baseline included sex, racial or ethnic identity, age, employment, physical activity, anthropometry, education, oral health status, lifestyle behaviors, medical and family history of chronic diseases and cancer, sex-specific health questions, and medication use.

The NCI diet questionnaire (15 pages) was a comprehensive and widely used instrument assessing a broad range of dietary behaviors and food types. The Food Frequency Questionnaire (FFQ) captures food pyramid servings and frequency across food groups and the use of supplements and vitamins, as well as alcohol consumption. It also allows calculation of nutrient intake, glycemic index and load, and meat-related intake variables. To reflect cultural variation, culturally specific modules were incorporated. For example, Korean-identifying participants received a questionnaire with additional Korean food items and context.

Both demographic and diet questionnaires were available in English, Korean, Mandarin, and Spanish. Together, the questionnaires required approximately 1 hour to complete. Participants returned completed forms by mail or completed them online via REDCap. All questionnaire data were stored in REDCap under each participant's unique identification number. Paper questionnaires received by mail were scanned as PDFs and digitized using Remark Office Optical Mark Recognition (OMR) software. Data are stored on a password-protected, Health

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

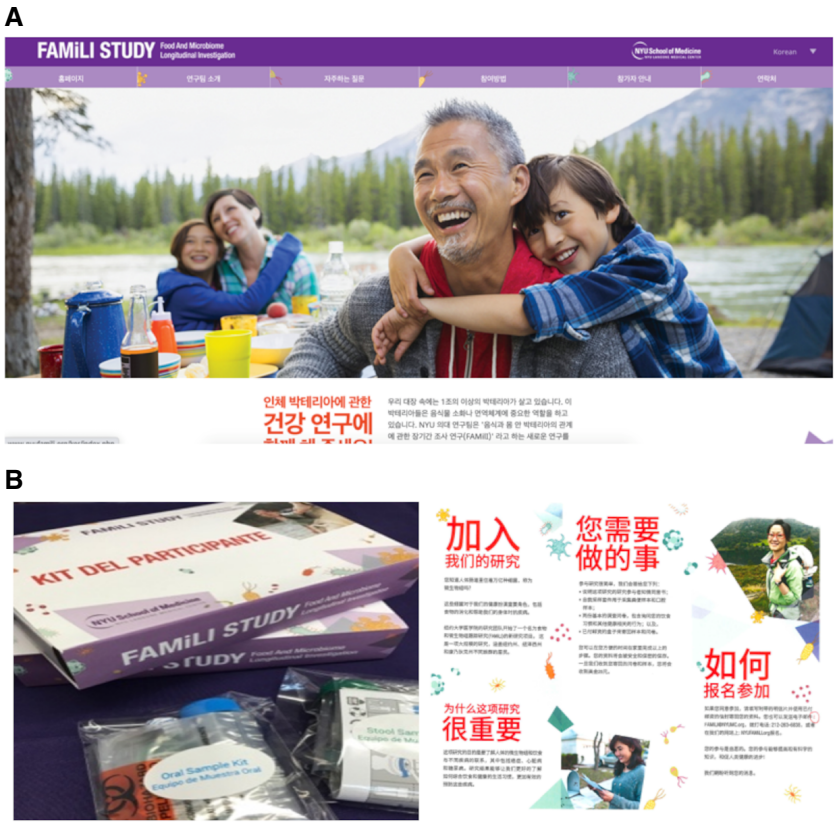


Figure 2.
FAMiLI Study website, recruitment, and study materials. **A,** Cohort webpage (sign up/questionnaires). Participants could indicate interest, sign-up, and complete questionnaires electronically. **B,** FAMiLI study recruitment and study materials. All study materials were provided in English, Korean, Mandarin, and Spanish, per the participant's preference.

Insurance Portability and Accountability Act (HIPAA)–compliant, NYU-secured server.

Biospecimen collection and management

At enrollment, participants who agreed to provide biospecimens receive study packages that include detailed instructions and biospecimen collection kits. Participants who chose not to provide biospecimens remained in the study. During phase I recruitment, 95% of participants provided buccal cell and stool samples. Silicone wristbands were newly introduced in phase II recruitment, in addition to the phase I collections (**Table 1**).

Buccal cell and stool biospecimens

Buccal cell and stool samples are critical resources for studies of the oral and gut microbiome, human genomics, metabolomic profiling, and other novel biomarkers of disease risk. For buccal cells, participants received a small volume of Scope mouthwash and were instructed to rinse with 10 mL before expectorating into the provided collection tube. For stool samples, participants were asked to collect approximately 2 teaspoons of stool in a 30-mL tube containing RNAlater stabilization solution. Both samples were sealed in the supplied specimen bags, and participants mailed them at room temperature directly to the NYU Central Biorepository using the provided prelabeled mailer. Upon receipt, stool samples were homogenized on a Vortex-Genie 2 with a multitube holder at the highest speed for 20 minutes and then aliquoted into six 1.8-mL cryotubes. Oral wash samples were centrifuged at 4,000 rpm for 30 minutes. The supernatants were aliquoted into two 5-mL cryotubes, and the pellets were aliquoted into five 1-mL cryotubes.

Silicone wristband sampling for personal monitoring of physical environment pollutants

Silicone wristbands are passive personal samplers for assessing exposure to chemical mixtures (9). These wristbands adsorb semivolatile organic compounds from air, dust, and everyday products, capturing both inhalation and dermal pathways (10–12). Chemical concentrations in wristbands correlate strongly with serum and urinary biomarkers, validating their use as external indicators of internal dose for compounds with short or long biological half-lives. Participants are instructed to wear the provided wristband on either wrist at all times for 1 week, record the times when they put it on, and remove it in a log attached to the wristband sealed return shipment bag. A broad range of exposures can be quantified in wristband samples mostly using gas chromatography with mass spectrometry (GC-MS/MS; ref. 13). The NYU Human and Environmental Analysis Laboratory recently validated extraction and LC/MS-MS analysis of 13 per- and polyfluoroalkyl substances (PFAS), 6 bisphenols, and 9 organophosphate flame retardants in wristbands.

Sample shipment and monitoring: Home-collected biospecimen and wristband samples are tracked during shipment, and receipt is confirmed by the NYU Langone Smilow Research Center Central Biorepository. Upon arrival, samples are verified against REDCap, entered into the Laboratory Information Management System, and stored at −80°C in freezers.

Quality control: Repeated samples will be collected from 20 subjects in years 3 and 5 to assess temporal stability. Data and sample

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

Table 2. Information collected in the FAMiLI.

Data type		Variable
	Built environment	*Geocoding*: neighborhood environment, racial segregation, ethnic enclave, ethnic food access, food environment, street noise, density, crime and safety, and access to health care
	Outdoor air	*Geocoding*: air pollution and climate change
	Indoor air	*Questionnaire*: indoor air, home fuel, residential history, and home environment
	Personal chemical exposure	*Wearable silicon wristband*: Polychlorinated Biphenyls (PCBs), Brominated Flame Retardant/ Polybrominated diphenyl ethers (PBDEs), Organophosphate esters (OPEs), phthalates, pesticides, and Polycyclic aromatic hyrocarbons (PAHs).
	Sociocultural influences	*Questionnaire*: nativity, immigration patterns, acculturation scale, social networks, and kinship structure, education, income, occupation, English proficiency, and health insurance
	Psychology	*Questionnaire*: PROMIS *questionnaire* (quality of life), anxiety, and depression
Diet/lifestyle	*Questionnaire*: demographic, tobacco, diet, exercise and body size, sleep, comorbidities, medication, and reproductive factors	
	Oral/buccal	Human genomics, epigenomics, and oral microbiome
	Stool	Gut and oral microbiome, metabolomics, and other omics

collection is conducted using established Standard Operating Procedures (SOP). All assays will include 5% blinded quality control samples, and staff is blinded to outcomes. Instruments are operated by nationally certified and state-licensed technicians who meet continuing education requirements and industry compliance standards.

Data linkage: Geocoding-based environment

We use batched automated geocoding of current and former residential addresses. The program Geocodio then provides automated linkage of spatial coordinates to a deep library of geo-referenced data, including air pollution and the built environment.

Outdoor air assessment and climate

We employ 2 fine particle exposure databases—one nationwide at the census tract level based on Environmental Protection Agency (EPA) surveys and a more spatially detailed assessment for New York City (NYC)—to estimate trace element exposures among cohort participants. Since 2008, the NYC Department of Health has operated ~150 air pollution monitors (14), measuring $PM_{2.5}$ and gaseous pollutants in a highly spatially granular manner (NYC Community Air Survey; ref. 14). Small area $PM_{2.5}$ measures have been developed by land use regression models (available at 300 × 300 m; ref. 15). Furthermore, $PM_{2.5}$ elemental composition analysis, based on X-ray fluorescence, is calculated with high validity for 5 environmental exposure groups (16), representing nontail pipe emissions (copper, iron, and zinc), long-range transport (sulfur), oil burning/industry emissions (nickel and vanadium), crustal material (silicon), and biomass burning (potassium). Across the United States, annual average $PM_{2.5}$, trace element, and source-specific exposures will be assigned to participants using a spatiotemporal prediction model previously developed at the census tract level (17). For quality assurance, the 2 $PM_{2.5}$ constituent datasets will be compared in NYC, where both are available. High-resolution climate data, including temperature and humidity, are publicly accessible and will be incorporated into exposure assessments (18).

Socioeconomic neighborhood environment

US Census Bureau's American Community Survey and census data will be used to characterize census tract–level averages of education, employment, housing, residential racial segregation, and poverty. Established indices such as the neighborhood deprivation index and social vulnerability index are also publicly available (19, 20). Current participant addresses and their neighborhood socioeconomic status are shown in **Fig. 3**.

Built environment

For residents of NYC and other cities of >50,000 population, neighborhood data from the City Health Dashboard (21) will be used to describe the built environment in participants' census tracts, including 37 measures of health and determinants of health equity. Built environment indicators include walkability, limited access to healthy food, surface temperature and greenness, building types (high rise vs. single unit), housing with potential lead risk, heating source, and public housing, using the NYU Department of Population Health City Health Dashboard (22).

Participant retention and follow-up for incident health outcomes

Retention strategy

Retention is promoted by emphasizing the importance of the study, maintaining strong staff–participant rapport, and fostering participant engagement. To sustain ongoing contact, participants will receive electronic birthday cards and annual newsletters demonstrating study updates and new findings.

Follow-up survey

Process: Three years after enrollment, participants will receive a follow-up survey via email online or mailed paper survey. Surveys will update health status and lifestyle changes, including acculturation and weight change. Based on the current response rate, approximately 80% of participants are expected to respond via a secure emailed questionnaire, with the remainder (20%) using a paper version. For participants whose email or survey mailing is undeliverable, contact information will be updated through commercial tracing services, including Whitepages and LexisNexis. If participants cannot be located, relatives or friends provided as contacts at baseline will be contacted. Deaths will be identified through the National Death Index (NDI).

Verification: Disease incidence will be confirmed. Affirmative responses indicating selected new medical conditions in the follow-up survey will trigger a telephone interview by research staff to complete a detailed event-specific questionnaire. Participant authorization will be obtained for medical chart release.

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

Table 3. Selected baseline demographic characteristics.

Characteristic	Overall (*N* = 11,610)	AsA-NHPI (*N* = 4,833)	White (*N* = 5,618)	Black (*N* = 684)	Other or missing race (*N* = 475)	Hispanic (*N* = 682)	Non-Hispanic (*N* = 10,877)	Missing ethnicity (*N* = 51)
Age								
<49 years	24.6%	20.7%	25.9%	34.8%	33.3%	32.1%	24.2%	10.3%
50–59 years	28.1%	23.3%	30.4%	39.1%	33.8%	33%	27.8%	37.9%
60–69 years	27.5%	26.7%	29.4%	20.8%	21.7%	23.1%	27.8%	37.9%
70+ years	19.8%	29.3%	14.2%	5.3%	11.1%	11.8%	20.3%	13.8%
Female, %	68.7%	63.1%	73.2%	73.4%	66.3%	68.7%	68.8%	48.1%
Ever smokers, %	31%	24.2%	36.4%	32%	34%	32.4%	31%	40%
BMI median (kg/m^2; IQR)	25.2 (22.5–29.2)	23.7 (21.6–25.9)	26.6 (23.3–31.5)	30.2 (25.8–35.3)	27.5 (24–31.9)	28.1 (24.6–32.4)	25.1 (22.4–29.1)	25.3 (23.9–30.1)
Foreign born, %	45%	93.7%	6.8%	8.7%	57.4%	58%	44.2%	35.7%
Education								
<11 years	6.3%	10.8%	1.4%	2.5%	28.5%	25.6%	5.1%	7.1%
High school to < college	29.9%	33.5%	24.6%	43.7%	35.4%	37.9%	29.4%	17.9%
College graduate	34.2%	35.4%	34.9%	29.7%	19.3%	18.8%	35.2%	35.7%
Postgraduate	29.5%	20.3%	39.1%	24.1%	16.8%	17.7%	30.3%	39.3%

NOTE: Study recruitment is ongoing. The data presented here include only a subset of participants whose samples and data had been processed as of March 26, 2026.

Reported cardiovascular disease (CVD) or other major disease events and hospitalizations will be verified through review of relevant medical records, including emergency visits, hospitalizations, outpatient records, and death certificates. CVD events and cause of death will be adjudicated by an outcome assessment group led by two cardiologists.

Definition of incident diseases and mortality outcomes

CVD cases: Stroke is defined as nonfatal stroke, fatal stroke, or carotid endarterectomy (CEA). Nonfatal strokes are classified as ischemic, hemorrhagic, or undetermined based on medical record review, particularly CT and MRI results. Fatal strokes are confirmed when the underlying cause of death from the NDI is cerebrovascular disease specific to stroke [International Classification of Diseases, 10th Revision (ICD-10) I60–I64.9]. CEAs are confirmed via medical record review. Coronary heart disease (CHD) includes nonfatal myocardial infarction (MI; cardiovascular survey methods, 1982, World Health Organization Monograph Series Number 56), fatal CHD, coronary artery bypass grafting, and percutaneous transluminal coronary angioplasty. Fatal CHD is confirmed either by autopsy or when the NDI lists CHD as the underlying cause of death (ICD-10 I20–I25) in conjunction with evidence of preexisting CHD from questionnaires or medical records. The expected numbers of CVD cases are listed in **Table 4**.

Diabetes cases: At the clinical exam, data will be collected on self-reported physician-diagnosed type 2 diabetes and prescription of diabetes medication (insulin or oral glucose-lowering drugs). Type 2 diabetes was defined using measures of fasting glucose (126 mg/dL) at the clinical examination, use of diabetes medication, reported physician-diagnosed diabetes, or record of diabetes in the EHR database (ICD-10 code E11).

Cancer: Cancer cases are identified through the Virtual Pooled Registry Cancer Linkage System (VPR-CLS) North American Association of Cancer Registries, covering nationwide cancer registries. Approximately 850 cases have been identified. Systematic follow-up for cancer through VPR-CLS will continue on a routine basis.

Mortality: Deaths are identified via the NDI, which provides causes of death. For deaths potentially related to incident CVD or other diseases of interest, hospital records will be obtained with next-of-kin permission. The underlying cause of death will be determined based on medical records and participant medical history.

Results

FAMiLI cohort research agenda

Our broad scientific vision focuses on key research areas for investigating health outcomes in this uniquely AsA-enriched multiethnic

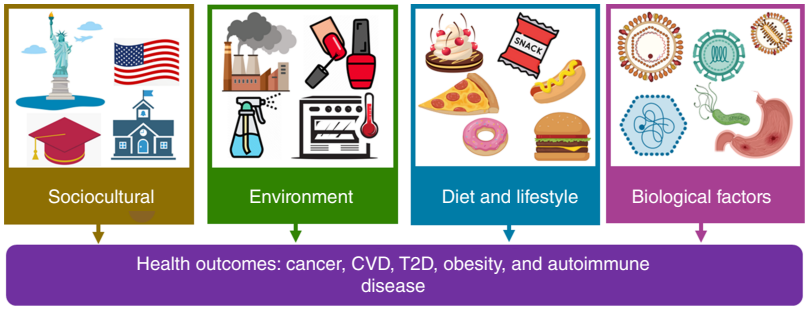


Figure 3.
FAMiLI research priorities. Our broad scientific vision focuses on key research areas for investigating health outcomes in this uniquely AsA-enriched multiethnic cohort, encompassing sociocultural, dietary and physical activity, environmental, and biological factors. T2D, type 2 diabetes.

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

Table 4. Expected number of health outcome.

Number	Overall	Korean	Chinese
Prevalent diseases as of now			
CVD	1,284	320	315
CHD	691	183	162
Stroke	387	112	107
Diabetes	1,492	473	461
Incident in year 5[a]			
CVD	543	132	123
CHD	284	75	63
Stroke	152	46	38
Diabetes	302	87	75

[a]Based on AsA incidence rate from Centers for Disease Control National Health Interview Survey.

cohort (**Fig. 3**), encompassing sociocultural, dietary and physical activity, environmental, and biological factors.

Research agenda 1: Sociocultural factors, nativity, acculturation, and immigration stress

Including both first- and multi-generation AsA immigrants allows assessment of how acculturation affects cardiometabolic disease risk. Asian immigrants and their descendants adopt aspects of US culture to varying degrees, undergoing an acculturative process involving lifestyle and value changes in response to a different societal context (8). Small studies have shown differential cardiometabolic disease risks among Korean and Chinese American adults by nativity, degree of acculturation, immigration patterns, duration of US residency, and English proficiency (23). Sociocultural factors such as immigration stress, English proficiency, trust in Western medicine, and educational attainment may also influence access to timely prevention and treatment (24). We will evaluate whether social and cultural adaptation processes influence the incidence and mortality of CVD and its related comorbidities.

Research agenda 2: Diet, neighborhood environment, and walkability

AsA immigrants and their offspring face numerous dietary challenges in the United States. With acculturation, their diets may include more unhealthy "Westernized" foods (e.g., desserts, high-fat meat, and snacks; ref. 25) while limiting traditionally healthy Asian diets rich in vegetables, legumes, and soy. Diets may also retain less healthy Asian "festival foods" high in carbohydrates, animal protein, sugar, and fat (26), which are often readily available in urban ethnic enclaves. Living in ethnic enclaves such as Chinatown (Manhattan) and Koreatown (Queens) may limit neighborhood walkability, commonly described by the "D variables"—density, diversity, design (street connectivity), destination accessibility, and distance to transit (27). Greater neighborhood walkability is associated with higher total physical activity (28), higher engagement in active transport (27) and, in cross-sectional studies, with lower body mass index (BMI) and lower prevalence of obesity (29). AsA tend to have higher risks of diabetes even at a lower BMI (30). AsA also tend to have high abdominal and visceral fat, with poorer metabolic consequences than in other racial/ethnic groups (31). In New York Black and White adults, neighborhood walkability is associated with obesity-related disease mortality and, in women, with levels of endogenous hormones (32). Our FAMiLI data showed that greater neighborhood deprivation in the New York metropolitan area was related to risk of obesity (33). The FAMiLI cohort will address the role of the neighborhood, energy balance, and related metabolic consequences in the prospective risk of cardiometabolic disease in AsA.

Research agenda 3: Environmental pollutants

Environmental exposure is responsible for 35% of the global CVD burden (34). In the United States, AsA rank second of 7 racial and ethnic groups in terms of hazardous ambient air pollution, only behind Black populations (35). AsA are also potentially at risk for indoor exposure to air pollutants through high-temperature cooking practice (36), including exposure to heterocyclic amines (37) and polycyclic aromatic hydrocarbons (38). AsA are also overrepresented in certain occupations that may carry chemical hazards, including in nail salons, dry cleaning, hairdressing, and restaurant cooking. Recent research in National Health and Nutrition Examination Survey (NHANES) 2003 to 2014 pointed to the potential role of environmental heavy metals, individually and as mixtures, in obesity, hypertension, CVD, and diabetes (39). Mixtures of toxic metals (40) such as arsenic, lead, and cadmium, potentially result in synergistic effects (41), as suggested in NIEHS's priorities (42). Additionally, environmentally ubiquitous and persistent PFASs, some of which have biological half-lives ranging from years to decades (43), have been associated with incident CVD (44). The most common PFASs have been examined in NHANES participants, with detection of some species in nearly all participants (range, 30%–100%; ref. 45). Emerging research suggests that newer, short-chain PFAS may also have adverse cardiovascular effects (43); however, no studies have assessed levels of PFASs in AsA. In the FAMiLI, we will have exceptional opportunities to investigate environmental factors for cardiometabolic and other diseases using: i, validated questions on indoor exposures including cooking practices and occupations (46), ii, in-house capacity for measurement of organic pollutants and metals in wearables and biosamples (47–49), and iii, rich spatial environmental data from New York City Department of Health and Mental Hygiene (14).

Research agenda 4: Multiomics biological factors

Germline genomics: Genome-wide association studies of CVD-related endpoints have been conducted in East Asian residents in Asia (50, 51), but not in AsA populations. Efforts to evaluate polygenic risk score (52) for risk stratification have also not prominently included AsA populations, recognizing that most data are for Europeans and that variant frequency and correlation patterns vary across ancestral groups (53). Also, cultural and environmental factors unique to AsA populations may modulate the importance of genetic variation. Genome-wide interaction study (GWIS) may also contribute to further understanding the etiology of CVD and other complex diseases (54) in AsA populations. Emerging GWISs on cardiovascular traits have identified new genetic markers not previously reported by GWISs (55), for example, relating lipids and lipid metabolism to gene–tobacco smoking and gene–physical activity interactions (56); however, GWIS investigations for CVD in AsA have been limited (57).

Human microbiome: There is strong evidence that microbiome composition differs by geographic location (58), but our understanding of the reasons for these patterns is incomplete. We showed that nativity and acculturation influence the microbiome in AsA (59). With collection of fecal and oral samples, we will investigate the role of genomics and the microbiome and their interactions with environmental factors in relation to cardiometabolic disease in AsA.

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

Discussion and conclusion

The FAMiLI cohort offers a unique platform to examine how sociocultural, behavioral, environmental, and biological factors converge to influence health disparities for AsA populations. By integrating detailed measures of acculturation, diet, physical activity, neighborhood context, and metabolic health, FAMiLI will clarify mechanisms underlying health disparities in AsA and inform culturally tailored prevention strategies. The study's findings are expected to advance the understanding of disease etiology, guide targeted interventions, and illuminate how individual- and community-level determinants jointly shape health outcomes in AsA populations.

Data Availability

Building on the Findable Accessible Interoperable Reusable (FAIR) data principles, we implemented a data sharing policy consistent with the NIH Data Sharing Policy (NOT-OD-03-032). The FAMiLI informed consent allows sharing and deposition of data in NIH-designated repositories. FAMiLI is registered in the NCI Cohort Database, and digital object identifiers (DOI) are assigned to publications and associated datasets to enable linkage and access. FAMiLI shares data through 2 mechanisms:

1) Broad data sharing: Currently, raw sequencing data from the FAMiLI are available in the NIH-designated repository (#PRJNA559143). We will continue to deposit data generated, including deidentified baseline and follow-up data and other genomic data to the Database of Genotypes and Phenotypes (dbGAP) and the FAMiLI webpage.
2) FAMiLI collaboration: Biospecimens and related phenotype data are available through collaborative proposals. The FAMiLI website provides study descriptions, data dictionaries, and information on available data and biospecimens, along with instructions for submitting requests through a streamlined online system. Applications will undergo rolling review by the Steering Committee, with an expected 3-month turnaround. Approved investigators will gain access to biospecimens stored at NYU upon project approval, IRB approval, and execution of a Data/Material Transfer Agreement with FAMiLI.

Data were generated by the authors but are not publicly available because of ongoing study operations and IRB regulations but are available upon reasonable request to the corresponding author.

Authors' Disclosures

S.S. Yi reports other support from Re:Culture Health outside the submitted work. No disclosures were reported by the other authors.

Authors' Contributions

J. Ahn: Conceptualization, resources, data curation, supervision, funding acquisition, writing–original draft, writing–review and editing. **Z. Halloran:** Resources, data curation, investigation, methodology, project administration. **D.B. Beggs:** Resources, data curation, visualization, project administration. **F. Wu:** Data curation, project administration. **Y. Duan:** Data curation, investigation, project administration. **H. Hwang:** Resources, data curation, project administration. **Z. Zhu:** Data curation, investigation, project administration. **V. Flores:** Data curation, investigation, project administration. **V. Albergamo:** Conceptualization, investigation, methodology. **S. Kwak:** Data curation, validation, visualization, writing–review and editing. **S. Kim:** Conceptualization, resources, project administration. **S. Mei:** Conceptualization, resources, project administration. **L.N. Đoàn:** Conceptualization, writing–review and editing. **S.S. Yi:** Conceptualization, writing–review and editing. **H. Li:** Data curation, supervision, investigation, writing–review and editing. **R.B. Hayes:** Conceptualization, resources, supervision, writing–review and editing.

Acknowledgments

Research reported in this publication was supported in part by the US NIH under award numbers U24ES036002, P20CA252728, R01CA159036, U01CA250186, R01HL178710, and UH3HL1169656, received by J. Ahn. The authors express sincere appreciation to FAMiLI participants and to each member of the study team. The authors thank Vicente for his valuable input on the FAMiLI cohort work.

Received January 28, 2026; revised March 24, 2026; accepted June 25, 2026; posted first June 29, 2026.

References

1. Krogstad J, Im C. Key facts about Asians in the U.S. Washington (DC): Pew Research Center; [cited 2025 May 1]. Available from: https://www.pewresearch.org/short-reads/2025/05/01/key-facts-about-asians-in-the-us/.
2. Martin DN, Lam TK, Brignole K, Ashing KT, Blot WJ, Burhansstipanov L, et al. Recommendations for cancer epidemiologic research in understudied populations and implications for future needs. Cancer Epidemiol Biomarkers Prev 2016;25:573–80. https://doi.org/10.1158/1055-9965.epi-15-1297.
3. Guan A, Talingdan AS, Tanjasiri SP, Kanaya AM, Gomez SL. Lessons learned from immigrant health cohorts: a review of the evidence and implications for policy and practice in addressing health inequities among Asian Americans, native Hawaiians, and Pacific Islanders. Annu Rev Public Health 2024;45:401–24. https://doi.org/10.1146/annurev-publhealth-060922-040413.
4. Kanaya AM, Hsing AW, Panapasa SV, Kandula NR, Araneta MRG, Shimbo D, et al. Knowledge gaps, challenges, and opportunities in health and prevention research for Asian Americans, native Hawaiians, and Pacific Islanders: a report from the 2021 National Institutes of Health Workshop. Ann Intern Med 2022;175:574–89. https://doi.org/10.7326/M21-3729.
5. Awata H, Linder S, Mitchell LE, Delclos GL. Biomarker levels of toxic metals among Asian populations in the United States: NHANES 2011-2012. Environ Health Perspect 2017;125:306–13. https://doi.org/10.1289/ehp27.
6. Grineski S, Morales DX, Collins T, Hernandez E, Fuentes A. The burden of carcinogenic air toxics among Asian Americans in four US metro areas. Popul Environ 2019;40:257–82. https://doi.org/10.1007/s11111-018-0308-4.
7. Varshavsky JR, Morello-Frosch R, Harwani S, Snider M, Petropoulou SE, Park JS, et al. A pilot biomonitoring study of cumulative phthalates exposure among Vietnamese American nail salon workers. Int J Environ Res Public Health 2020;17:325. https://doi.org/10.3390/ijerph17010325.
8. Salant T, Lauderdale DS. Measuring culture: a critical review of acculturation and health in Asian immigrant populations. Soc Sci Med 2003;57:71–90 https://doi.org/10.1016/s0277-9536(02)00300-3.
9. Anderson KA, Points GL 3rd, Donald CE, Dixon HM, Scott RP, Wilson G, et al. Preparation and performance features of wristband samplers and considerations for chemical exposure assessment. J Expo Sci Environ Epidemiol 2017;27:551–9. https://doi.org/10.1038/jes.2017.9.
10. Hammel SC, Phillips AL, Hoffman K, Stapleton HM. Evaluating the use of silicone wristbands to measure personal exposure to brominated flame retardants. Environ Sci Technol 2018;52:11875–85. https://doi.org/10.1021/acs.est.8b03755.
11. Wang S, Romanak KA, Hendryx M, Salamova A, Venier M. Association between thyroid function and exposures to brominated and organophosphate flame retardants in rural central Appalachia. Environ Sci Technol 2020;54:325–34. https://doi.org/10.1021/acs.est.9b04892.
12. Wang S, Romanak KA, Stubbings WA, Arrandale VH, Hendryx M, Diamond ML, et al. Silicone wristbands integrate dermal and inhalation exposures to semi-volatile organic compounds (SVOCs). Environ Int 2019;132:105104. https://doi.org/10.1016/j.envint.2019.105104.
13. Wise CF, Hammel SC, Herkert N, Ma J, Motsinger-Reif A, Stapleton HM, et al. Comparative exposure assessment using silicone passive samplers indicates that domestic dogs are sentinels to support human health research. Environ Sci Technol 2020;54:7409–19. https://doi.org/10.1021/acs.est.9b06605.
14. Ito K, Johnson S, Kheirbek I, Clougherty J, Pezeshki G, Ross Z, et al. Intra-urban variation of fine particle elemental concentrations in New York City. Environ Sci Technol 2016;50:7517–26. https://doi.org/10.1021/acs.est.6b00599.
15. Clougherty JE, Kheirbek I, Eisl HM, Ross Z, Pezeshki G, Gorczynski JE, et al. Intra-urban spatial variability in wintertime street-level concentrations of multiple combustion-related air pollutants: the New York City Community

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

Air Survey (NYCCAS). J Expo Sci Environ Epidemiol 2013;23:232–40. https://doi.org/10.1038/jes.2012.125.
16. Medgyesi DN, Fisher JA, Flory AR, Hayes RB, Thurston GD, Liao LM, et al. Evaluation of a commercial database to estimate residence histories in the Los Angeles ultrafines study. Environ Res 2021;197:110986. https://doi.org/10.1016/j.envres.2021.110986.
17. Rahman MM, Thurston G. A hybrid satellite and land use regression model of source-specific PM(2.5) and PM(2.5) constituents. Environ Int 2022;163:107233. https://doi.org/10.1016/j.envint.2022.107233.
18. Patz JA, Frumkin H, Holloway T, Vimont DJ, Haines A. Climate change: challenges and opportunities for global health. JAMA 2014;312:1565–80. https://doi.org/10.1001/jama.2014.13186.
19. Neighborhood Atlas. Madison (WI): Center for the Health Disparities, University of Wisconsin.
20. Graham Center. Maps data tools - social deprivation index.
21. Gourevitch MN, Athens JK, Levine SE, Kleiman N, Thorpe LE. City-level measures of health, health determinants, and equity to foster population health improvement: the City Health Dashboard. Am J Public Health 2019;109:585–92. https://doi.org/10.2105/ajph.2018.304903.
22. NYU Department of Population Health. City Health Dashboard.
23. Morey BN, Ryu S, Shi Y, Park HW, Lee S. Acculturation and cardiometabolic abnormalities among Chinese and Korean Americans. J Racial Ethn Health Disparities 2023;10:1605–15. https://doi.org/10.1007/s40615-022-01347-x.
24. Đoàn LN, Chau MM, Ahmed N, Cao J, Chan SWC, Yi SS. Turning the health equity lens to diversity in Asian American health profiles. Annu Rev Public Health 2024;45:169–93. https://doi.org/10.1146/annurev-publhealth-060222-023852.
25. Satia JA, Patterson RE, Taylor VM, Cheney CL, Shiu-Thornton S, Chitnarong K, et al. Use of qualitative methods to study diet, acculturation, and health in Chinese-American women. J Am Diet Assoc 2000;100:934–40. https://doi.org/10.1016/S0002-8223(00)00269-8.
26. Azar KM, Chen E, Holland AT, Palaniappan LP. Festival foods in the immigrant diet. J Immigr Minor Health 2013;15:953–60. https://doi.org/10.1007/s10903-012-9705-4.
27. Freeman L, Neckerman K, Schwartz-Soicher O, Quinn J, Richards C, Bader MD, et al. Neighborhood walkability and active travel (walking and cycling) in New York City. J Urban Health 2013;90:575–85. https://doi.org/10.1007/s11524-012-9758-7.
28. Frank L, Kerr J, Rosenberg D, King A. Healthy aging and where you live: community design relationships with physical activity and body weight in older Americans. J Phys Act Health 2010;7(Suppl 1):S82–90. https://doi.org/10.1123/jpah.7.s1.s82.
29. Rundle A, Neckerman KM, Freeman L, Lovasi GS, Purciel M, Quinn J, et al. Neighborhood food environment and walkability predict obesity in New York City. Environ Health Perspect 2009;117:442–7. https://doi.org/10.1289/ehp.11590.
30. Shai I, Jiang R, Manson JE, Stampfer MJ, Willett WC, Colditz GA, et al. Ethnicity, obesity, and risk of type 2 diabetes in women: a 20-year follow-up study. Diabetes Care 2006;29:1585–90. https://doi.org/10.2337/dc06-0057.
31. Le Marchand L, Wilkens LR, Castelfranco AM, Monroe KR, Kristal BS, Cheng I, et al. Circulating biomarker score for visceral fat and risks of incident colorectal and postmenopausal breast cancer: the Multiethnic Cohort Adiposity Phenotype Study. Cancer Epidemiol Biomarkers Prev 2020;29:966–73. https://doi.org/10.1158/1055-9965.EPI-19-1469.
32. India-Aldana S, Rundle AG, Zeleniuch-Jacquotte A, Quinn JW, Kim B, Afanasyeva Y, et al. Neighborhood walkability and mortality in a prospective cohort of women. Epidemiology 2021;32:763–72. https://doi.org/10.1097/ede.0000000000001406.
33. Kwak S, Beggs D, Kwon S, Choi H, Wu F, Li H, et al. Neighborhood socioeconomic status and risk of obesity in a multi-ethnic population in the US. SER Abstract. 2024.
34. WHO. Preventing disease through healthy environments: a global assessment of the burden of disease from environmental risks. Geneva (Switzerland): World Health Organization; 2016.
35. Grineski SE, Collins TW, Morales DX. Asian Americans and disproportionate exposure to carcinogenic hazardous air pollutants: a national study. Soc Sci Med 2017;185:71–80 https://doi.org/10.1016/j.socscimed.2017.05.042.
36. Wang TJ, Zhou BS, Shi JP. Lung cancer in nonsmoking Chinese women: a case-control study. Lung Cancer 1996;14(Suppl 1):S93–8. https://doi.org/10.1016/s0169-5002(96)90214-7.
37. IARC Monographs. Some naturally occurring substances: food items and constituents, heterocyclic aromatic amines and mycotoxins. Vol. 56. Lyon (France): IARC Monographs; 1993.
38. Straif K, Baan R, Grosse Y, Secretan B, El Ghissassi F, Cogliano V, et al. Carcinogenicity of polycyclic aromatic hydrocarbons. Lancet Oncol 2005;6:931–2. https://doi.org/10.1016/s1470-2045(05)70458-7.
39. Wang X, Mukherjee B, Park SK. Associations of cumulative exposure to heavy metal mixtures with obesity and its comorbidities among U.S. adults in NHANES 2003-2014. Environ Int 2018;121:683–94. https://doi.org/10.1016/j.envint.2018.09.035.
40. Cobbina SJ, Chen Y, Zhou Z, Wu X, Feng W, Wang W, et al. Low concentration toxic metal mixture interactions: effects on essential and non-essential metals in brain, liver, and kidneys of mice on sub-chronic exposure. Chemosphere 2015;132:79–86. https://doi.org/10.1016/j.chemosphere.2015.03.013.
41. Lister LJ, Svendsen C, Wright J, Hooper HL, Spurgeon DJ. Modelling the joint effects of a metal and a pesticide on reproduction and toxicokinetics in Lumbricid earthworms. Environ Int 2011;37:663–70. https://doi.org/10.1016/j.envint.2011.01.006.
42. Carlin DJ, Rider CV, Woychik R, Birnbaum LS. Unraveling the health effects of environmental mixtures: an NIEHS priority. Environ Health Perspect 2013;121:A6–8. https://doi.org/10.1289/ehp.1206182.
43. Podder A, Sadmani AHMA, Reinhart D, Chang N-B, Goel R. Per and polyfluoroalkyl substances (PFAS) as a contaminant of emerging concern in surface water: a transboundary review of their occurrences and toxicity effects. J Hazard Mater 2021;419:126361. https://doi.org/10.1016/j.jhazmat.2021.126361.
44. Abdullah Soheimi SS, Abdul Rahman A, Abd Latip N, Ibrahim E, Sheikh Abdul Kadir SH. Understanding the impact of perfluorinated compounds on cardiovascular diseases and their risk factors: a meta-analysis study. Int J Environ Res Public Health 2021;18:8345. https://doi.org/10.3390/ijerph18168345.
45. Huang M, Jiao J, Zhuang P, Chen X, Wang J, Zhang Y. Serum polyfluoroalkyl chemicals are associated with risk of cardiovascular diseases in national US population. Environ Int 2018;119:37–46. https://doi.org/10.1016/j.envint.2018.05.051.
46. Vermeulen R, Downward GS, Zhang J, Hu W, Portengen L, Bassig BA, et al. Constituents of household air pollution and risk of lung cancer among never-smoking women in Xuanwei and Fuyuan, China. Environ Health Perspect 2019;127:97001. https://doi.org/10.1289/ehp4913.
47. Guo Y, Senthilkumar K, Alomirah H, Moon HB, Minh TB, Mohd MA, et al. Concentrations and profiles of urinary polycyclic aromatic hydrocarbon metabolites (OH-PAHs) in several Asian countries. Environ Sci Technol 2013;47:2932–8. https://doi.org/10.1021/es3052262.
48. Zhu H, Wang L, Liu C, Stryker Z, Loganathan BG, Kannan K. Phthalate metabolites, hydroxy-polycyclic aromatic hydrocarbons, and bisphenol analogues in bovine urine collected from China, India, and the United States. Environ Sci Technol 2019;53:11524–31. https://doi.org/10.1021/acs.est.9b04178.
49. Wang L, Asimakopoulos AG, Kannan K. Accumulation of 19 environmental phenolic and xenobiotic heterocyclic aromatic compounds in human adipose tissue. Environ Int 2015;78:45–50. https://doi.org/10.1016/j.envint.2015.02.015.
50. Lu X, Wang L, Chen S, He L, Yang X, Shi Y, et al. Genome-wide association study in Han Chinese identifies four new susceptibility loci for coronary artery disease. Nat Genet 2012;44:890–4. https://doi.org/10.1038/ng.2337.
51. Wen W, Zheng W, Okada Y, Takeuchi F, Tabara Y, Hwang JY, et al. Meta-analysis of genome-wide association studies in East Asian-ancestry populations identifies four new loci for body mass index. Hum Mol Genet 2014;23:5492–504. https://doi.org/10.1093/hmg/ddu248.
52. Khera AV, Chaffin M, Aragam KG, Haas ME, Roselli C, Choi SH, et al. Genome-wide polygenic scores for common diseases identify individuals with risk equivalent to monogenic mutations. Nat Genet 2018;50:1219–24. https://doi.org/10.1038/s41588-018-0183-z.
53. Martin AR, Gignoux CR, Walters RK, Wojcik GL, Neale BM, Gravel S, et al. Human demographic history impacts genetic risk prediction across diverse populations. Am J Hum Genet 2017;100:635–49. https://doi.org/10.1016/j.ajhg.2017.03.004.
54. Said MA, van de Vegte YJ, Zafar MM, van der Ende MY, Raja GK, Verweij N, et al. Contributions of interactions between lifestyle and genetics on coronary artery disease risk. Curr Cardiol Rep 2019;21:89. https://doi.org/10.1007/s11886-019-1177-x.

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026

55. Kilpeläinen TO, Bentley AR, Noordam R, Sung YJ, Schwander K, Winkler TW, et al. Multi-ancestry study of blood lipid levels identifies four loci interacting with physical activity. Nat Commun 2019;10:376. https://doi.org/10.1038/s41467-018-08008-w.
56. Bentley AR, Sung YJ, Brown MR, Winkler TW, Kraja AT, Ntalla I, et al. Multi-ancestry genome-wide gene-smoking interaction study of 387,272 individuals identifies new loci associated with serum lipids. Nat Genet 2019;51:636–48. https://doi.org/10.1038/s41588-019-0378-y.
57. Gauderman WJ, Mukherjee B, Aschard H, Hsu L, Lewinger JP, Patel CJ, et al. Update on the state of the science for analytical methods for gene-environment interactions. Am J Epidemiol 2017;186:762–70. https://doi.org/10.1093/aje/kwx228.
58. Ahn J, Hayes RB. Environmental influences on the human microbiome and implications for noncommunicable disease. Annu Rev Public Health 2021;42:277–92 https://doi.org/10.1146/annurev-publhealth-012420-105020.
59. Peters BA, Yi SS, Beasley JM, Cobbs EN, Choi HS, Beggs DB, et al. US nativity and dietary acculturation impact the gut microbiome in a diverse US population. ISME J 2020;14:1639–50. https://doi.org/10.1038/s41396-020-0630-6.

Downloaded from aacrjournals.org/cebp/article-pdf/35/9/1517/3822860/epi-26-0178.pdf by NYU Medical Center user on 10 November 2026