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# 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

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## Abstract

Asian Americans (AsA), Native Hawaiians, and Pacific Islanders (NHPI) comprise 7.7% of the U.S. population, and AsA have had the fastest growth rate since 2010. Yet the National Institutes of Health (NIH) has invested only 0.17% of its budget on AsA and NHPI research between 1992 and 2018. More than 40 ethnic subgroups are included within AsA and NHPI (with no majority subpopulation), which are highly diverse culturally, demographically, linguistically, and socioeconomically. However, data for these groups are often aggregated, masking critical health disparities and their drivers. To address these issues, in March 2021, the National Heart, Lung, and Blood Institute, in partnership with 8 other NIH institutes, convened a multidisciplinary workshop to review current research, knowledge gaps, opportunities, barriers, and approaches for prevention research for AsA and NHPI populations. The workshop covered 5 domains: 1) sociocultural, environmental, psychological health, and lifestyle dimensions; 2) metabolic disorders; 3) cardiovascular and lung diseases; 4) cancer; and 5) cognitive function and healthy aging. Two recurring themes emerged: Very limited data on the epidemiology, risk factors, and outcomes for most conditions are available, and most existing data are not disaggregated by subgroup, masking variation in risk factors, disease occurrence, and trajectories. Leveraging the vast phenotypic differences among AsA and NHPI groups was identified as a key opportunity to yield novel clues into etiologic and prognostic factors to inform prevention efforts and intervention strategies. Promising approaches for future research include developing collaborations with community partners, investing in infrastructure support for cohort studies, enhancing existing data sources to enable data disaggregation, and incorporating novel technology for objective measurement. Research on AsA and NHPI subgroups is urgently needed to eliminate disparities and promote health equity in these populations.

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In 2020, Asian Americans (AsA), Native Hawaiians, and Pacific Islanders (NHPI) comprised 7.7% of the total U.S. population (23.9 million AsA and 1.6 million NHPI) (1). Asian Americans had the fastest growth (38.6%) since 2010 (1) and are projected to surpass 46 million by 2060 (2). These numbers encompass tremendous heterogeneity among the 40 AsA and NHPI ethnic subgroups with respect to indigeneity, nativity or ancestry, culture, immigration patterns, acculturation, educational attainment, income, language, and

English proficiency, all of which influence health, health care access, and outcomes (3). However, in most national surveys, health systems data, and studies, these groups are often aggregated, rendering many groups invisible, masking important social and health differences, and skewing health policy and allocation of resources (4). Several novel clues to disease etiology and phenotypic presentations reside within these vastly heterogeneous populations, which would advance disease prevention and clinical care approaches in AsA and NHPI and beyond. The underrepresentation of these populations in health research both undermines health equity and limits important scientific discoveries.

Currently, only 2% of nearly 245 000 participants in the 14 largest National Heart, Lung, and Blood Institute (NHLBI)-supported cohorts have AsA or NHPI ancestry. A review of clinical research funded by the National Institutes of Health (NIH) between 1992 and 2018 found that studies focusing on AsA and NHPI comprised only 0.17% of the total NIH budget over those 26 years (5).

To eliminate health disparities, achieve health equity, and identify untapped scientific potential through the inclusion of AsA and NHPI in future research, the NHLBI, in partnership with 8 other NIH institutes, convened a multidisciplinary workshop, “Identifying Research Opportunities for Asian American, Native Hawaiian, and Pacific Islander Health.” In this paper, we summarize the findings, and synthesize the gap and opportunity areas identified from the workshop to guide future directions of health and prevention research on AsA and NHPI.

## Methods

The 3-day workshop (31 March to 1 April 2021) assembled leading experts from multiple disciplines with the following objectives: 1) review the current research in AsA and NHPI populations for common chronic conditions and their risk factors, morbidity, and mortality; 2) uncover knowledge gaps; 3) identify research opportunities; 4) highlight challenges related to conducting health research across and within these groups; and 5) brainstorm effective approaches to engage AsA and NHPI communities in partnership to achieve health equity. Workshop participants are listed in the Appendix (available at Annals.org).

The workshop included 5 major domains that represented common chronic conditions and risk factors among AsA and NHPI populations and priority areas for the 9 participating NIH institutes. These domains included 1) sociocultural, environmental, psychological health, and lifestyle dimensions; 2) metabolic disorders; 3) cardiovascular and lung diseases; 4) cancer; and 5) cognitive function and healthy aging.

For a thorough landscape survey of these 5 domains and to facilitate in-depth discussions, the workshop included 22 presentations with 4 moderated discussion sessions, 2 panel discussions on effective approaches for community engagement and partnerships necessary for the success of longitudinal cohort studies, and a final session devoted to discussing research opportunities.

For the first 2 days, invited experts summarized the current research in AsA and NHPI populations and provided insights on the gaps, opportunities, and barriers. Moderators for

each domain facilitated a discussion of the expert panel and summarized key research findings and opportunities. The final day of the workshop centered on brainstorming effective strategies to engage AsA and NHPI community partners for collaboration to advance health research among AsA and NHPI subgroups. A panel of experts on community-engaged research and another panel with longitudinal cohort experience discussed unique challenges and successes related to study design, recruitment, and retention of AsA and NHPI participants. A final moderated session included discussions aimed at synthesizing key opportunities and approaches needed to advance health research for each domain area.

## Results

### Current Knowledge and Gaps

The Figure shows a heat map matrix depicting the prevalence, incidence, or mortality from chronic health conditions for aggregated and, if available, disaggregated AsA and NHPI groups in comparison to the U.S. White population. Many conditions are more common among AsA and NHPI than in the White population, or data are insufficient. Table 1 summarizes the current health research and corresponding gaps by domain for AsA and NHPI populations. Cross-cutting themes across all domains included: 1) scarce data on prevalence, incidence, risk factors, and outcomes; 2) existing data are not sufficiently disaggregated; and 3) heterogeneity of risk factor prevalence and disease incidence among the diverse AsA and NHPI subgroups. These findings underscore the importance of studying subgroups separately to yield specific and unique insights needed to develop effective and targeted prevention strategies for these groups.

### Sociocultural, Environmental, Psychological Health, and Lifestyle Dimensions

Health and chronic diseases have multilevel drivers, including structural, cultural, environmental, interpersonal, psychological, and individual lifestyle factors. To unravel these complex relationships, it is imperative to investigate these multilevel factors individually and jointly. Because 57% of AsA are immigrants (foreign-born), whereas NHPI are primarily native-born but historically colonized (6, 7), studying changes in psychosocial and lifestyle dimensions by level of immigration patterns, acculturation, and generational status provides unique insights into disease occurrence, prevention, and outcomes. Psychological factors have been associated with a wide array of health conditions and mortality among AsA and NHPI (7). Mental health problems are prevalent and increasing in AsA and NHPI, but stigmatization and a paucity of culturally valid assessment tools contribute to underdiagnosis of psychological disorders and low admission and utilization rates of mental health services (8-11).

Lifestyle dimensions, including tobacco and e-cigarette use, diet, physical activity, and sleep, play an important role in health and chronic diseases. Several studies have found that neighborhood context, social support, and acculturation patterns affect individual lifestyle behaviors across AsA and NHPI subgroups (12-16). There is considerable variation in smoking prevalence, dietary patterns, and physical activity levels in AsA and NHPI. Physical activity levels are lower among AsA and NHPI than the White population

(17), and AsA and NHPI undergo dietary transitions after immigration or with a greater exposure to an American diet (18, 19). Sleep deficiency and poor sleep quality among AsA and NHPI populations have been linked to adverse health outcomes, including obesity, diabetes, hypertension, and cardiovascular disease (CVD) (20-22). Compared with the U.S. White population, AsA and NHPI groups tend to have shorter sleep duration, lower sleep efficiency, less time in deep sleep, and a higher risk for obstructive sleep apnea, despite AsA having a lower body mass index (BMI) (23-26).

## Metabolic Disorders

Despite lower BMI in most AsA subgroups, many metabolic disorders, including type 2 diabetes mellitus (T2DM), hypertension, nonalcoholic fatty liver disease, and dyslipidemia, are very common conditions in AsA and NHPI. Imaging studies using dual energy X-ray absorptiometry and magnetic resonance imaging for ectopic fat (abdominal visceral fat and hepatic fat) quantification have shown higher amounts of visceral and hepatic fat in several AsA groups compared with U.S. White, Black, and Latino populations (27, 28). Ectopic fat measures have much stronger associations with cardiometabolic disease in AsA and NHPI populations than BMI (28-30).

Diabetes is a recognized health disparity among AsA and NHPI groups (31-33). Among AsA, the South Asian and Filipino subgroups have the highest rates of T2DM, surpassing those of Latino, Black, and Native American groups; East Asian subgroups (Chinese, Japanese, and Korean) also have higher rates than the U.S. White population (34-36). Among NHPI, diabetes is significantly more common (34) and occurs 10 to 15 years earlier (37) than in the U.S. White population. Among AsA and NHPI, chronic kidney disease is usually exacerbated by the high prevalence of T2DM (31, 38); studies have shown a higher prevalence of chronic kidney disease in NHPI groups compared to most U.S. race or ethnic groups (39, 40).

## Cardiovascular Disease

Although overall CVD mortality rates have been declining in the United States since 2000, ischemic heart disease mortality rates have stagnated in Asian Indian and Vietnamese men and heart failure mortality rates have increased in Filipino, Asian Indian, and Japanese women and men, Vietnamese women, and Korean men (Shah N. Personal communication.). Hypertension, a major CVD risk factor, is higher among Filipino and South Asian populations than among the U.S. White population (41, 42). Subclinical measures of atherosclerosis (that is, coronary artery calcium), the strongest predictor of CVD, are rarely studied in AsA groups (43, 44), and prognostic data for atherosclerotic cardiovascular disease events exist only for Chinese Americans (45). Compared to the U.S. White population, AsA and NHPI groups have younger age of onset and age at hospitalization for heart failure (46-48). Hemorrhagic stroke is a common problem in AsA and NHPI. Compared to the U.S. White population, many AsA subgroups, in particular Filipino, have a higher incidence or mortality from hemorrhagic stroke (49-51), and NHPI experience hemorrhagic stroke at younger ages with a higher number of risk factors (52).

## Cancer

Cancer is the leading cause of death in AsA overall, specifically among Chinese, Korean, Vietnamese, Thai, and Laotian Americans. Native Hawaiians have the highest mortality rates for all types of cancer relative to the U.S. White population; cancer is the most rapidly increasing cause of death among Native Hawaiian and Chamorro subgroups (53-58). There is vast heterogeneity in cancer risk and outcomes across AsA and NHPI populations (54, 57-60): Korean American, Japanese American, Native Hawaiian, and American Samoan populations have higher risk for gastric cancer than the U.S. White population (58, 59, 61); liver cancer incidence has been high among Chinese, Korean, Vietnamese American, Native Hawaiian, and American Samoan populations (62-65). Cancer screening rates in AsA and NHPI are generally low. Currently, no national screening guidelines for early detection of high-risk cancers in AsA and NHPI (gastric, liver, and lung) are available (66, 67).

## Cognitive Function and Healthy Aging

Healthy aging, functional ability, and Alzheimer disease and related dementias (ADRD) have not been well studied in most AsA and NHPI groups (68). Few studies of cognitive aging among older Chinese and Japanese American populations are available (69, 70), and 1 study comparing 4 AsA groups reported higher incidence of dementia among Filipino than Chinese, Japanese, and South Asian American subgroups (71).

## Knowledge Gaps

Many gaps exist in the epidemiology and risk factors for most chronic conditions in AsA and NHPI subgroups, we have identified potentially addressable gaps based on existing knowledge of unique phenotypes within certain ethnic groups (Table 1).

## Opportunities and Barriers

Table 2 highlights major research opportunities that leverage unique phenotypes among AsA and NHPI groups (from Table 1) or are most feasible in advancing science. For example, studying subgroups with divergent body composition (AsA groups with higher visceral and hepatic fat at low BMI vs. NHPI groups with more lean muscle mass and high BMI) who are at higher risk for T2DM can elucidate the underlying biology and the relationships between multilevel factors for a better understanding of disease mechanisms and prevention for many populations. We can also probe unique pathways that link diabetes with heart disease and stroke by studying specific AsA and NHPI groups at higher risk for T2DM but have divergent risk for atherosclerotic CVD and stroke. Given the higher risk for mortality from hemorrhagic stroke in some AsA populations, there is an urgent need to determine the mechanisms underlying risk to prevent stroke for safer use of anticoagulant treatments in these populations.

A critical opportunity is to enhance electronic health records and claims data by collecting detailed (standardized) AsA and NHPI ethnicity, nativity and birthplace, language, generational status, length of residence, and other social determinants of health. Used in conjunction with data from existing surveillance and behavioral risk factor surveys, these data could further our understanding of multilevel determinants of a wide range of common diseases in AsA and NHPI and other U.S. groups.

A cost-effective and scientifically sound approach is to leverage existing infrastructure in ongoing prospective cohort studies integrating recruitment of additional AsA and NHPI groups. For example, studies of aging using the standardized Health and Retirement Survey could expand recruitment to include specific AsA and NHPI subgroups. Such expansion would facilitate measurement standardization and comparative studies with other race or ethnic groups.

Barriers to AsA and NHPI research corresponding to opportunities in each domain are summarized in Table 2. One of the key challenges is building trust within each community to establish authentic partnership and long-term engagement with academic investigators for collaborations. Another major challenge is the lack of validated tools and survey instruments that are linguistically and culturally appropriate for these diverse populations.

### Practical Approaches

We propose specific complementary and integrated strategies for future AsA and NHPI research in Table 3 and the Appendix Figure (available at Annals.org). An optimal design would use a community-engaged and participatory framework that builds capacity and trust among academic researchers and community stakeholders to establish mutually beneficial research partnerships. Within this framework, an effective strategy is to employ a populomics approach (that is, measuring the complex interplay of sociobehavioral, community, and biological factors within the context of the health care system) (72) or an exposome approach (that is, measuring all exposures of an individual across the lifespan) for prospective cohort studies designed with adequate sample sizes by ethnic subgroup. Such cohorts can include immigrants and subsequent generations to examine the intersections of sociocultural and multilevel drivers on health and outcomes. It would be highly efficient to leverage ongoing data collection for existing cohorts or surveillance studies by expanding sampling frames to capture more ethnic subgroups, in addition to adding detailed ethnicity and nativity variables to enable data disaggregation. Investments in basic infrastructure support, such as repositories of validated instruments, statistical tools, and biobanks that are linked to phenotypic data sets, would also enable cross-ethnic research. Lastly, incorporation of modern technology, such as imaging, digital, mobile, and biosensing tools, is critical for capturing more objective phenotypic data.

## Discussion

Asian Americans, Native Hawaiians, and Pacific Islanders are heterogenous populations with diverse multilevel risk profiles, phenotypic presentations, and health disparities in many chronic diseases. For many conditions, AsA and NHPI are more likely to be diagnosed at a younger age, or a later stage, and have a worse prognosis, although specific data on morbidity and mortality for many subgroups are lacking. The key recurring themes across all domains were the paucity of AsA and NHPI–focused research for many lifestyle behaviors and health conditions and that most of the existing data on AsA and NHPI are not appropriately disaggregated. Furthermore, the NIH investment in research of this growing American subpopulation has been woefully low to date (5).

Due to striking phenotypic differences within and across AsA and NHPI populations, their expansion and inclusion in health research will provide crucial and unique opportunities to uncover novel leads into cause and outcomes. For example, the paradoxical relationship between low or normal BMI yet high prevalence of T2DM and other metabolic disorders among specific AsA populations is distinct and has promising potential for clinical and biological mechanism discovery. Given the low BMI yet high ectopic fat and low muscle mass often observed among AsA, imaging methods should be incorporated into future studies to more accurately characterize body adiposity and muscle mass to clarify the biological underpinnings of this paradox and provide mechanistic insights into the development and progression of many metabolism-related diseases.

Community engagement is vital to improve research participation and quality. To successfully address the health needs of AsA and NHPI and leverage opportunities to advance health research, it is imperative to build representative research teams and a workforce within AsA and NHPI communities. Studies should integrate social, behavioral, environmental, and biological factors within a multilevel populomicsframework (72) to address the determinants of health and health disparities as proposed by the National Institute on Minority Health and Health Disparities (73). This successful approach has also been the cornerstone of the NHLBI cohort study (the Hispanic Community Health Study/Study of Latinos) and could serve as a model for future NIH investments into AsA and NHPI prospective cohorts.

The limited investment by the NIH in AsA and NHPI health and prevention research may have stemmed from the continuing myth of the “model minority” stereotype for AsA or a misconception that AsA are a homogenous demographic group, further perpetuated by the continuing practice of aggregating these diverse groups in federally funded research and publications (4). There are ample opportunities to improve data availability, including development of statistical approaches for analyses of data for numerically smaller populations and determining annual population denominators. Other sources of data, such as electronic health records, administrative claims, and admissions or encounters data should consistently collect information regarding specificAsA and NHPI ethnic identity (including mixed ancestral backgrounds), language, and immigration factors. Some health systems have included ethnic subgroup data, enabling the creation of highly useful clinical and administrative data sets to yield novel findings about disease epidemiology and outcomes among several AsA and NHPI groups and several other race or ethnic groups in the United States (31, 34, 74-76). While these health systems include data on race and ethnicity, there remain areas of necessary data collection, including country of birth, length of U.S. residence, generational status, and English language proficiency. These immigration-related variables comprise a range of barriers as well as opportunities for improving health care access and lifestyle behaviors, and ultimately for mitigating health disparities (77, 78).

To achieve health equity, we need broader policy changes, including more tangible directed research funding, grant review panels that include members representing these diverse communities and researchers with expertise in working with these populations, and mandates to governmental and health systems that require data disaggregation by ethnic

origin groups. The goal is to support representation, inclusion, and equity and to leverage the unparalleled diversity of the United States for scientific gain.

In summary, this report presents the relevant findings and highlights knowledge gaps, research opportunities, potential barriers, and actionable approaches that can yield new leads for disease cause and prognostic factors to inform prevention and clinical care among AsA and NHPI. Integrating scientific goals with the priorities of AsA and NHPI community partners is vital to ensuring participation and impact when conducting epidemiologic, clinical, and prevention research to reduce the burden of chronic diseases and health disparities. Ultimately, addressing these gaps and barriers will inform how public health and health care providers prevent and manage chronic diseases among AsA and NHPI. This report serves as a blueprint to advance health justice for all AsA and NHPI populations.

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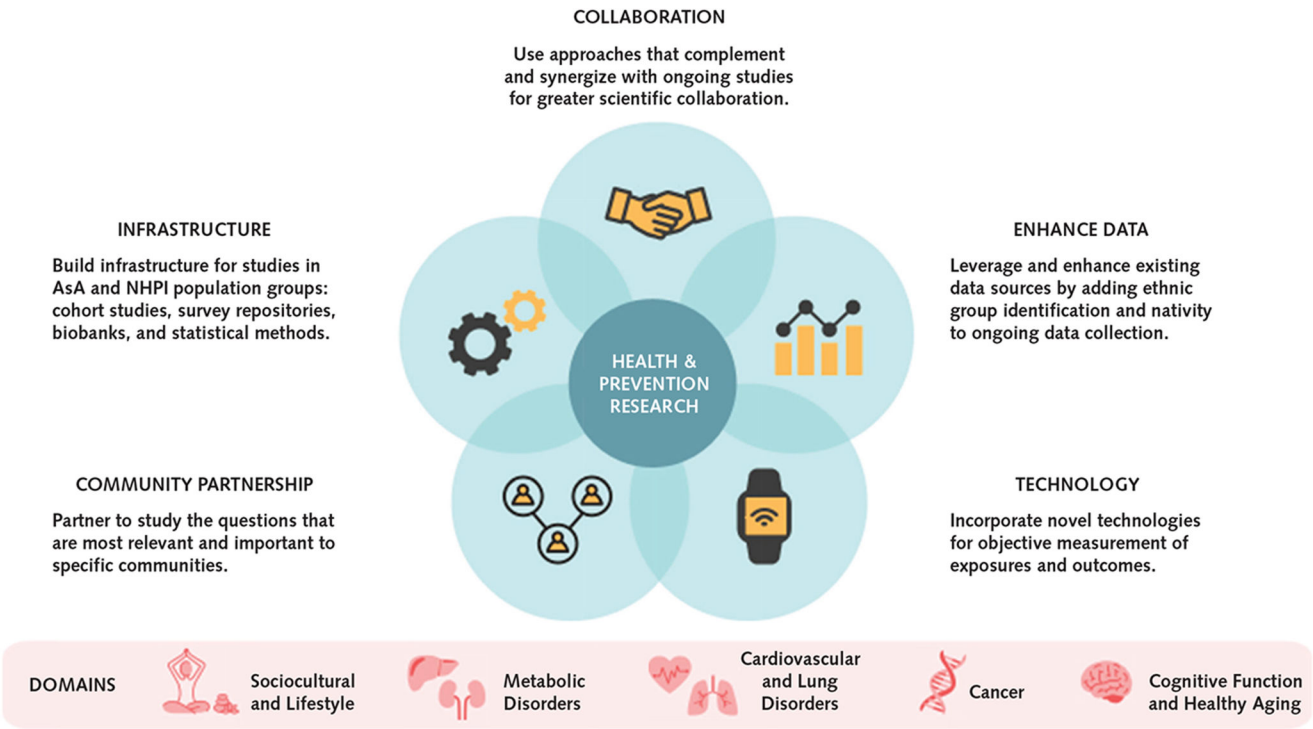


**Appendix Figure.**

Key approaches needed to improve prevention research in AsA and NHPI populations, 2021 NIH Workshop.

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## Key Summary Points

Asian Americans (AsA), Native Hawaiians, and Pacific Islanders (NHPI) comprise 7.7% of the U.S. population and include more than 40 ethnic groups that are highly diverse culturally, demographically, linguistically, and socioeconomically. Much of the existing data about AsA and NHPI are aggregated across groups, which obscures important disparities in health and results in knowledge gaps about common health conditions among specific AsA and NHPI groups.

Approximately 57% of AsA and 17% of NHPI are foreign-born. Collecting and integrating data about each group's ancestry and nativity, immigration patterns, generational status, length of residence, and acculturation level will provide unique insights into novel etiologic factors, phenotypic patterns, and prognostic factors that influence health.

There is limited or no data on the incidence, prevalence, and risk factors of many common chronic conditions (diabetes, kidney disease, cardiovascular disease, lung disorders, cancer, and cognitive impairment) in specific AsA and NHPI subgroups.

There is a critical need to capture specific and accurate AsA and NHPI ethnic identification and nativity and ancestry, using standardized coding methods, in existing and ongoing data collection sources to facilitate data disaggregation and pooling across data sources.

There is an urgent need to develop an innovative research infrastructure to support well-powered and representative prospective cohorts to understand mechanisms of disease with appropriate data disaggregation across AsA and NHPI subgroups. Equally important are the development of culturally and linguistically appropriate instruments and measures and the creation of survey and other data repositories linked to biobanks.

It is essential to use community-engaged approaches and partner with community organizations and trusted gatekeepers to effectively study health issues that reflect community priorities. These partnerships promote development of culturally relevant strategies, enhance workforce diversity, recruitment and retention efforts, and ultimately evidence-based preventive services and clinical care tailored for AsA and NHPI groups.

Future studies should incorporate the latest technologies, including bioimaging techniques, biosensing and digital platforms, and -omics, to facilitate objective assessment and real-time data capture to understand different phenotypes and causal mechanisms underlying exposures and outcomes among AsA and NHPI populations.

**Figure. Heatmap matrix of chronic health conditions in AsA and NHPI compared with White U.S. adults, 2021 NIH Workshop.**

Numbers in parentheses are references. AsA = Asian American; AVFA = abdominal visceral fat area; CHD = coronary heart disease; CKD = chronic kidney disease; HCC = hepatocellular carcinoma; HCVA = hemorrhagic cerebrovascular accident; HTN = hypertension; ICVA = ischemic cerebrovascular accident; NAFLD = nonalcoholic fatty liver disease; T2DM = type 2 diabetes mellitus.

* Data from U.S. Census 2020 for each race category alone and in combination with another race group for AsA and NHPI (1); ACS 2019 data are used for estimates of AsA subpopulations (3).

† Prevalence by body mass index criteria.

**Table 1.**

Current Knowledge and Gaps in Health and Prevention Research Among AsA and NHPI, 2021 NIH Workshop

| Domain | What We Know (Current Knowledge) | What We Need to Know (Gaps) |
|---|---|---|
| **Sociocultural, environmental, and psychological health, and lifestyle dimensions** | | Need longitudinal studies of lifestyle dimensions and mental health effects on health outcomes, focusing on changes over time by immigration and generational status. |
| Sociocultural influences | AsA and NHPI experience interpersonal and structural discrimination based on race, religion, and color, and it is detrimental to health (79-82).<br>Acculturation is associated with health; this relationship is modified by health outcome, gender, and SES (15, 83).<br>Differences in social network size, composition, and social support exist across AsA and NHPI subgroups (84, 85).<br>Social network size and network behavior are associated with lifestyle factors and CVD (12-14, 86). | How do immigration patterns, acculturation, discrimination, social networks, and kinship structures intersect and affect health?<br>What is the influence of multiple forms of discrimination (e.g., structural, interpersonal, internalized) on health outcomes?<br>Do acculturation level or patterns differ by ethnic subgroup and gender, and what factors determine these patterns? |
| Environment | Environmental exposure (e.g., air pollution), neighborhood, occupational, and sociocultural context are linked to health behaviors and outcomes (24, 87-89).<br>Ethnic enclaves correlate with health behaviors, including smoking, alcohol use, walking, and diet (90-92).<br>Neighborhoods with a higher proportion of Chinese and Korean Americans have the greatest risk for higher outdoor carcinogenic hazardous pollution, followed by South Asian Americans (92), compared with White neighborhoods.<br>High proportion of the NHPI are exposed to toxic waste (industrial and freeway pollution) (93) than other race/ethnic groups. | How do neighborhood and other environmental factors affect health behaviors and outcomes?<br>Do ethnic enclaves provide social support or other resilience resources to mitigate poor health outcomes? |
| Psychological health | Mental health disorders are underdiagnosed in all AsA and NHPI subgroups (9).<br>AsA and NHPI have lower admission and utilization rate of mental health services (7).<br>There are large differences in the prevalence of depression, anxiety, stress, and loneliness across AsA and NHPI subgroups (10).<br>Population heterogeneity, cultural tradition, and stigmatization are linked to the prevalence and diagnosis of these mental conditions (11). | Need culturally appropriate and validated mental health assessment tools for AsA and NHPI.<br>How does mental health change over time and influence other health outcomes? |
| Tobacco | There are substantial differences in adult cigarette smoking within AsA and NHPI populations; Korean, Vietnamese, Filipino, and NHPI men have higher prevalence than White men (33, 76, 94, 95).<br>Women generally have lower smoking rates, but some English-proficient AsA women have similar smoking prevalence to White women (94, 95).<br>E-cigarette use is higher among Filipino and Korean Americans, particularly among younger populations (96). | Does tobacco use vary by English proficiency status and associate with health outcomes in different subgroups? |
| Diet | AsA and NHPI have diverse diets; they undergo dietary transitions after immigration (18, 97, 98), with an increased Western diet.<br>Diet quality is decreasing over time with longer length of residence in United States (19, 99). | Need culturally appropriate and validated dietary assessments tools for AsA and NHPI.<br>Does diet influence health outcomes by subgroup? |
| Physical activity | Physical activity is decreasing over time, leading to higher rates of obesity and cardiometabolic risk (100).<br>Relative to White Americans, AsA and NHPI have lower physical activity levels (17).<br>Individual, environmental, and interpersonal factors contribute to low level of physical activity (17). | Does physical activity affect other risk factors and health outcomes in different subgroups? |
| Sleep | Sleep disturbance are associated with adverse mental and physical health outcomes, including depression, obesity, hypertension, and CVD (20-22).<br>AsA and NHPI are less likely than the White population to experience the recommended sleep duration (23-25).<br>AsA are more likely to have a craniofacial profile prone to develop obstructive sleep apnea, which can result in higher CVD (101). | Does sleep and sleep apnea affect health outcomes in different subgroups?<br>Need objective assessments of multidimensional sleep (e.g., sleep duration, quality, efficiency) and sleep structure (light and deep sleep and REM sleep) on health outcomes by ethnic subgroup. |

| Domain | What We Know (Current Knowledge) | What We Need to Know (Gaps) |
|---|---|---|
| **Metabolic disorders** | | Why do AsA have higher ectopic fat than other race/ethnic groups, and how is ectopic fat linked to several health outcomes? |
| Body composition | Body composition (fat distribution and muscle mass) measured by anthropometry and imaging have shown distinct patterns among AsA and NHPI (27, 28, 102).<br>AsA and NHPI have higher amounts of body fat at lower BMI (by 3-4 kg/m$^2$) (28, 103, 104).<br>AsA and NHPI have higher amounts of abdominal visceral fat and hepatic fat as measured by imaging studies (27, 28, 102).<br>Ectopic fat measures have stronger correlations with cardiometabolic disease than BMI or waist circumference in AsA and NHPI (29, 30). | Relative to other groups, why do AsA have higher ectopic fat deposition, given the same level of BMI?<br>What biological mechanisms drive ectopic adiposity?<br>Why are AsA more prone to low muscle mass and sarcopenia (muscle loss with aging)?<br>Are there reliable nonimaging biomarkers to quantify ectopic fat depots? |
| T2DM | AsA and NHPI have a higher prevalence of T2DM than White Americans (33-36).<br>Within AsA, South Asian and Filipino subgroups have the highest prevalence and incidence of T2DM in the United States, surpassing White, Latino, Black, and Native American populations (32, 34, 36).<br>Among Native Hawaiians, AsA admixture is associated with higher T2DM risk and White admixture confers lower risk (105).<br>Among those with T2DM, compared with White Americans, NHPI have increased risk for myocardial infarction; Chinese, Filipino, and Japanese Americans have elevated risk for ESRD (31).<br>Non-U.S. born Pacific Islander, Chinese, and South, and Southeast Asian Americans have higher risk for gestational diabetes (106). | Why do South Asian, Filipino, and NHPI groups have higher T2DM incidence than other groups?<br>What biological mechanisms drive T2DM in AsA and NHPI? Do mechanisms differ by weight status?<br>Why is there more glucose intolerance among certain AsA subgroups (Filipino and Japanese American)?<br>Why are gestational diabetes rates higher in immigrant AsA and PI than in second- and third-generation women? |
| NAFLD | NAFLD affects 18% of AsA (107).<br>NAFLD prevalence is higher among U.S.-born AsA, relative to new immigrants (108, 109).<br>Lean NAFLD (among those with BMI <23 kg/m$^2$) is higher among AsA than other race/ethnic groups (110). | What is the prevalence of NAFLD and lean NAFLD in AsA and NHPI?<br>What are the risk factors for NAFLD and lean NAFLD?<br>What biological mechanisms drive NAFLD and lean NAFLD in AsA and NHPI? |
| Lipoproteins | Chinese and South Asian Americans have high ApoB/ApoA1 and non-HDL-to-HDL cholesterol ratios, which are associated with MI (111).<br>Native Hawaiian and Japanese Americans have lower prevalence of dyslipidemia compared with Filipino Americans in Hawaii (112). | What biological mechanisms drive dyslipidemia in different AsA and NHPI subgroups? |
| Kidney disease | AsA and NHPI have higher risk for early-stage CKD compared with White Americans (38-40, 113).<br>Risk for and progression of CKD is exacerbated by T2DM, which is higher in NHPI and AsA (114-116). | What biological mechanisms drive CKD in AsA and NHPI?<br>Why are there differences in diabetes outcomes among AsA subgroups and NHPI with CKD?<br>What factors link diabetes and CKD with CVD in AsA and NHPI? |
| **Cardiovascular and lung diseases** | | Need data on incidence, risk factors, awareness, treatment, and control by subgroup for all heart and lung disorders. What role do genetics and other omics play in CVD? |
| Hypertension | Hypertension prevalence is higher among some AsA groups and NHPI (33, 42, 117).<br>Among all AsA subgroups, Filipino and South Asian have the highest prevalence of hypertension (41, 76).<br>NHPI have the highest prevalence of hypertension compared with other race/ethnic groups (33).<br>Hypertension awareness, treatment, and control are lower among AsA and NHPI (118, 119). | What is the prevalence of hypertension, hypertension awareness, and control in different ethnic subgroups? |
| CHD and subclinical atherosclerosis | Prevalence of CHD is often aggregated for AsA and NHPI (120, 121).<br>Health systems data show large differences in incidence of ASCVD among AsA subgroups (122, 123).<br>Incidence of CAC is higher in South Asian men than other race/ethnic groups (43). | How does CVD (or CHD) risk factor management vary in AsA and NHPI subgroups? How can ethnic disparities be improved for cardiovascular outcomes?<br>Need to incorporate subclinical disease measures (e.g., CT angiographic plaque and carotid plaque) to understand disease progression.<br>What are the most predictive models for ASCVD risk by subgroup? |
| Cardiac function and heart failure | AsA and NHPI have younger age of onset and age at hospitalization for heart failure (46-48). | Need to incorporate subclinical disease measures, such as left ventricular mass/hypertrophy by echo or MRI in future studies. |

| Domain | What We Know (Current Knowledge) | What We Need to Know (Gaps) |
|---|---|---|
| | Native Hawaiian ancestry is associated with a higher risk for heart failure (124). | |
| Arrhythmias: AF and SCD | ECG-determined AF data are lacking in AsA and NHPI (125).<br>AsA with AF are less likely to be managed well by rhythm control strategies (126).<br>Data on SCD are very limited in AsA and almost none are available on NHPI (127).<br>Inherited arrhythmic disorders may cause ASCVD and may have varied genetic basis in AsA (128). | Need serial measurements of ECGs for more valid diagnoses of AF and other arrhythmias.<br>What is the prevalence of SCD by AsA and NHPI? |
| Hemorrhagic and ischemic stroke | Some Asian subgroups have higher risk for hemorrhagic but not ischemic stroke (49-51).<br>AsA and NHPI tend to have more severe clinical presentation and worse outcomes from hemorrhagic stroke (129).<br>There may be heterogeneity in stroke risk factors between AsA and NHPI (130). | Why do some AsA groups have higher risk or mortality for hemorrhagic stroke? How does this affect anticoagulation guidelines for these subgroups?<br>What is the prevalence and age-adjusted mortality rate for ischemic and hemorrhagic stroke by subgroup?<br>Why is there discordance between high ASCVD risk and low stroke risk in South Asian groups, contrasted with a high hemorrhagic stroke risk but low ASCVD risk in some East Asian groups, contrasted with a high ASCVD and high hemorrhagic stroke risk in Filipino groups? |
| Lung disease and lung function | AsA have relatively lower FEV and FVC (131-134).<br>Some AsA subgroups have a higher risk for asthma but a lower risk for COPD (134).<br>Filipino Americans have a high lifetime prevalence of asthma compared with other groups (134). | Need improved lung function reference values specifically for AsA and NHPI.<br>What is the prevalence of asthma and COPD by subgroup?<br>How do early life exposomic factors and nativity influence lung function or lung health over the life span? |
| **Cancer patterns, risk factors, and screening** | | Why do AsA and NHPI have much higher risk for certain cancers? What roles do genetics and other omics play in the etiology of cancer? |
| Patterns and trends | Cancer is the most common leading cause of death in AsA and NHPI overall and in most AsA subgroups (53-58).<br>There are striking disparities in cancer patterns among AsA and NHPI (54, 57-59).<br>Breast and colorectal cancer rates are increasing in most AsA subgroups (54, 57-59).<br>AsA are younger at diagnosis of breast, colorectal, and lung cancer (54, 58, 59, 135-137).<br>Liver cancer rates have been high but are declining; rates remain high among most Southeast Asian groups (62, 63).<br>Gastric cancer rates are persistently high among many East Asian groups, particularly Japanese and Korean Americans (61); Native Hawaiian and American Samoans also have high rates of gastric cancer (64).<br>Lung cancer risk is high among some nonsmoking AsA women (138).<br>American Samoan women more likely to be diagnosed with, and to die of, cervical cancer compared with White women (64).<br>Native Hawaiian groups have the highest cancer mortality rates, higher than White and Black populations (65). | Need annual population size estimates (denominator) for many AsA and NHPI subgroups to develop reliable incidence and mortality statistics and cancer trends by ethnic subgroup. |
| Risk factors | Most information on etiology on AsA-related cancer come from studies in Asia, less from AsA populations.<br>Risk factors for cancer vary by ethnic subgroup. For example, chronic infection with hepatitis B virus is associated with liver cancer in Chinese and Korean Americans, but hepatitis C is the key risk factor for liver cancer in Vietnamese, Japanese, and Mongolian Americans (62, 63).<br>Pancreatic cancer rates are increasing in most AsA and NHPI (139).<br>*Helicobacter pylori* infection is the key risk factor for gastric cancer in most AsA and NHPI (61, 140). | What factors influence cancer etiology and progression within subgroups? |
| Screening | Cancer screening metrics, including that for breast, cervical, lung, and colorectal cancer, in AsA and NHPI is below the Healthy People metrics (141-144).<br>Given unique disparities in risk and prognosis of certain cancers in AsA and NHPI, current screening eligibility criteria, | How can AsA- and NHPI-specific cancer screening guidelines be developed for cancers that are more common in AsA and NHPI, including stomach and liver cancer, and lung cancer among nonsmokers? |

| Domain | What We Know (Current Knowledge) | What We Need to Know (Gaps) |
|---|---|---|
| | recommendations, and physician practice guidelines do not address effective early detection in these populations (66, 67). | |
| **Domain** | **What We Know (Current Knowledge)** | **What We Need to Know (Gaps)** |
| **Healthy aging, dementia, and AD** | | Need serial and longitudinal data on health aging and ADRD in AsA and NHPI. What roles do genetics and other omics play in AD and ADRD? |
| Healthy aging | The main data sources used to monitor healthy aging in the United States (i.e., HRS and NHATS) include very limited AsA and NHPI data (145). | What is the prevalence of age-related conditions among AsA and NHPI? |
| AD and ADRD | Data on AD and ADRD in AsA and NHPI are very limited (68).<br>There are large ethnic differences in cognition in AsA and NHPI, but the data are largely in Chinese and Japanese Americans (69, 70), and lacking for South and Southeast Asian subgroups.<br>Filipino Americans had higher incidence of clinical dementia than Chinese, Japanese, and South Asian subgroups (71). | Need culturally and linguistically appropriate tools to assess cognitive function and AD/ADRDs.<br>What is the epidemiology of cognitive function in healthy elderly and AD/ADRDs in AsA and NHPI?<br>What mechanisms drive AD and ADRD in AsA and NHPI? Can omics provide greater insight into the development of these disorders? |

AD = Alzheimer disease; ADRD = Alzheimer disease and related dementias; AF = atrial fibrillation; ApoB/ApoA1 = apolipoprotein B/apolipoprotein A1; AsA = Asian American; ASCVD = atherosclerotic cardiovascular disease; BMI = body mass index; CAC = coronary artery calcium; CHD = coronary heart disease; CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; CT = computed tomography; CVD = cardiovascular disease; ECG = electrocardiography; echo = echocardiography; ESRD = end-stage renal disease; FEV = forced expiratory volume; FVC = forced vital capacity; HRS = Health and Retirement Study; MI = myocardial infarction; MRI = magnetic resonance imaging; NAFLD = nonalcoholic fatty liver disease; NIH = National Institutes of Health; NHATS = National Health and Aging Trends Study; NHPI = Native Hawaiian and Pacific Islander; REM = rapid eye movement; SCD = sudden cardiac death; SES = socioeconomic status; T2DM = type 2 diabetes mellitus.

**Table 2.**

Opportunities and Potential Barriers for Health and Prevention Research Among AsA and NHPI, 2021 NIH Workshop

| Opportunities and Barriers |
|---|
| **Sociocultural, environmental, and psychological health and lifestyle dimensions** |
| Sociocultural and environment:<br>The vast diversity in culture and lifestyles offers unique opportunities to carry out mixed-method studies (qualitative and quantitative) to understand the interaction of ethnicity, immigration status, culture, SES, gender roles, and socioecologic determinants on health outcomes.<br>Assess the effects of interpersonal and occupational and/or neighborhood exposures on health outcomes over time among specific AsA and NHPI subgroups with higher disease risk, using an intersectionality framework with demographic and sociocultural factors. |
| Psychological health:<br>Study the incidence, prevalence, risk factors, treatments, and outcomes of mental health conditions among AsA and NHPI and their intersection with other health conditions. |
| Lifestyle dimensions:<br>Address the gender gap in smoking and other tobacco product use, including uptake of smoking cessation medications, and investigate culturally appropriate approaches to quitting.<br>Incorporate change of dietary patterns, physical activity levels, and sleep among AsA and NHPI immigrant populations to examine effects on health outcomes.<br>*Barriers:*<br>Developing trust in communities for long-term engagement in research studies<br>Lack of existing tools and instruments for individual ethnic subgroups, accounting for cultural and generational status<br>Translations of tools into several commonly spoken languages<br>Overcoming stigma about mental health conditions<br>Geographic and socioeconomic diversity of these populations, with several communities residing in rural areas with limited reach for research participation (e.g., internet connectivity, distance to travel to clinical exams, community health centers without electronic health records) |
| **Metabolic disorders** |
| Metabolic conditions:<br>Understand the biology underlying higher body fat at lower BMI for specific AsA groups, contrasting with high lean muscle mass and high BMI in Pacific Islanders, and how both body types are associated with higher T2DM risk.<br>Contrast ethnic subgroups with high diabetes prevalence (i.e., Filipino, South Asian, Native Hawaiian, and Pacific Islander) but with disparate CVD outcome (high heart disease risk in all 3 groups, but lower stroke risk in South Asian and NHPI groups).<br>Compare and contrast AsA and NHPI subgroups on phenotypes, epidemiology, disease progression, pathophysiology, and response to therapies for several distinct metabolic and kidney conditions.<br>Determine the cause of isolated postchallenge hyperglycemia among selected AsA and identify biomarkers and/or other diagnostic tools/ algorithms for this condition.<br>Determine the cause underlying the higher risk for gestational diabetes for AsA and NHPI, particularly among immigrant women. |
| Imaging:<br>Use objective imaging measurements for body composition (whole-body DXA) and for NAFLD (ultrasound and FibroScan). |
| Omics and microbiome:<br>Use multiple omics, including genomics, social and environmental epigenomics, and the microbiome on metabolic outcomes, to understand the biological underpinnings. |
| CKD:<br>Determine optimal biomarkers to classify CKD at its earliest stages, identify the target site of injury and inflammation, explore biological pathways that promote kidney repair, and promote potential therapeutic development.<br>*Barriers:*<br>Lack of awareness of diabetes screening and prevention methods among AsA and some NHPI communities<br>Cost and accessibility of imaging for better body composition assessment (MRI, CT, whole-body DXA scans)<br>Inconvenience of fasting blood tests and 2-hour glucose tolerance tests for better T2DM and dyslipidemia classification |
| **Cardiovascular and lung diseases** |
| Existing databases:<br>Leverage the NIH HeartShare program, All of Us, disease registries, existing cohort studies, electronic health record data, and administrative data sets (e.g., CMS) to better understand the epidemiology of cardiovascular and lung diseases among AsA and NHPI.<br>What biology and risk factors underlie the higher ASCVD risk among certain subgroups (South Asian) vs. higher ischemic and hemorrhagic stroke risk in other subgroups (Chinese). |
| Risk prediction:<br>Develop ASCVD, stroke, AF, and SCD risk prediction models in AsA and NHPI.<br>Develop pharmacogenomic studies of anticoagulation and antiarrhythmic drugs for optimal therapy for AF. |
| Omics:<br>Study the genomic, proteomics, and metabolomics of cardiovascular and lung conditions. |
| Lung disorders:<br>Examine how environmental exposures among the prior generation, changing lifestyle, smoking behaviors, and nutrition influence risk for lung |

| Opportunities and Barriers |
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| disease and impaired lung structure and function.<br>Leverage existing imaging data from existing studies and clinical data sets to understand pulmonary structure-function relationships and establish<br>normative data on lung function in the United States with diverse AsA and NHPI representation.<br>*Barriers:*<br>Lack of awareness of CVDs and prevention methods among AsA and NHPI communities<br>Cultural views about prevention of common chronic conditions<br>Cost and accessibility of imaging (CT, MRI, echo), repeat ECGs, and pulmonary function tests<br>Measurement of risk factors preimmigration (environmental and other sociocultural factors) |
| **Cancer** |
| Multilevel cancer epidemiology cohort:<br>Develop large multilevel integrative cohorts to investigate specific cancer etiology, progression, survival, and survivorship. |
| Invest in statistical methods for population estimates:<br>Invest in infrastructure to support the development of statistical methods for estimating annual AsA and NHPI population sizes in specific subgroups. |
| Link cancer registry data with other databases:<br>Leverage rich data from NCI's SEER program for secondary data analysis to understand cancer patterns, trends, treatment, and outcomes as well as forecast in subgroups of AsA and NHPI.<br>Link SEER data to existing large data sets (electronic health records, genetic databases, etc.) to generate new knowledge, particularly descriptive epidemiology. |
| Omics and risk prediction for cancer prevention:<br>Investigate multilevel risk and protective factors for cancer and whether multiomic biomarkers can be used for prediction of risk or prognosis in AsA and NHPI. |
| Cancer screening:<br>Identify the reasons and factors underlying lower cancer screening uptake in these populations and develop effective strategies to improve the use of cancer screening.<br>*Barriers:*<br>Overcoming stigma of a cancer diagnosis<br>Lack of awareness of cancer screening and prevention methods among AsA and NHPI communities |
| **Cognitive functioning and healthy aging** |
| Healthy aging:<br>Collect nationally representative data on healthy aging, including oversampling of AsA and NHPI groups in national surveys (e.g., NHANES) and in existing longitudinal cohort studies (e.g., HRS, NHATS). |
| Standardized measures:<br>Participate in the international effort to standardize measures of late-life cognition and dementia through the Harmonized Cognitive Assessment Protocol. |
| Functional status:<br>Add functional status, a standard battery of tests, including cognitive tests to ongoing studies (e.g., NHANES, California Health Interview Survey, Multiethnic Cohort study, MESA, MASALA), and focus on identifying gender roles, lifestyle factors, and physical and social environments for healthy aging. |
| Morbidity of ADRD:<br>Conduct research to determine the incidence and prevalence of ADRD, rate of cognitive decline, and mortality, including biomarkers, brain imaging, pathologic features, and the frequency and impact of genetic factors in AsA and NHPI.<br>*Barriers:*<br>Recruitment of representative samples of each subgroup<br>Lack of validated and translated tools for cognitive function assessment for many subgroups<br>Stigma associated with ADRD |

ADRD = Alzheimer disease and related dementias; AF = atrial fibrillation; AsA = Asian American; ASCVD = atherosclerotic cardiovascular disease; BMI = body mass index; CKD = chronic kidney disease; CMS = Centers for Medicare & Medicaid Services; CT = computed tomography; CVD = cardiovascular disease; DXA = dual-energy X-ray absorptiometry; ECG = electrocardiography; echo = echocardiography; HRS = Health and Retirement Study; MASALA = Mediators of Atherosclerosis in South Asians Living in America; MESA = Multi-Ethnic Study of Atherosclerosis; MRI = magnetic resonance imaging; NAFLD = nonalcoholic fatty liver disease; NHANES = National Health and Nutrition Examination Survey; NHATS = National Health and Aging Trends Study; NHPI = Native Hawaiian and Pacific Islander; NIH = National Institutes of Health; SCD = sudden cardiac death; SEER = Surveillance, Epidemiology, and End Results ; SES = socioeconomic status; T2DM = type 2 diabetes mellitus.

**Table 3.**

Suggested Approaches for Investigators to Improve the Quality and Impact of Health and Prevention Research Among AsA and NHPI, 2021 NIH Workshop*

| Approaches and Specific Steps |
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| **I. Engage and build sustainable partnership with AsA and NHPI communities.**<br>*Partner with AsA and NHPI community-based organizations and community leaders to build sustainable partnership to enhance participation, engagement, recruitment, retention, study implementation, capacity building, and outcome dissemination.* |
| Community-engaged partnership:<br>Develop a community-engaged approach focusing on patient-centered outcomes within a community context, partnering with community organizations and community leaders to build capacity for research.<br>Forge strong and sustainable relationships and build research coalitions with community-based organizations before initiating the study and hire culturally and linguistically competent staff and community health workers to improve recruitment materials, engagement methods, results interpretation, and dissemination. |
| Capacity building:<br>Recognize that not all communities have the ability or expertise to conduct research; help build their capacity through communication and training in study design, operation, and implementation to enhance sustainability and long-term relationships.<br>Facilitate study participation by incorporating flexible clinic hours, use community-based settings for in-person exams, provide transportation assistance and adequate remuneration.<br>Focus on patient-centered outcomes, within a community context aimed at practical benefits (e.g., technical and material assistance, education of youth), and commit to data equity and data ownership for the community. |
| Probability samples:<br>Develop a system or methods for probability sampling (covering all socioeconomic strata and other relevant demographic strata) for more valid population-specific representation with community outreach efforts for recruitment. |
| **II. Build infrastructure for studies in AsA and NHPI population groups**.<br>*Develop a state-of-the-art research infrastructure to serve as the platform to collaborate, coordinate, and implement innovative research in AsA and NHPI populations.* |
| AsA and NHPI prospective cohorts:<br>Develop multiple prospective cohort studies with novel approaches, deep phenotyping, serial measurements, and follow-up. Include sufficient sample size in distinct AsA and NHPI subgroups for valid comparison of exposures, genotype, phenotype, and outcomes for common chronic conditions in these groups.<br>Include multigenerational cohorts, hybrid cohorts (traditional epidemiologic cohorts supplemented by data from electronic health records), and immigrant cohorts.<br>Use a populomics approach (72) with multilevel, multicentered, multidisciplinary methods to investigate the risk factors, progression, and outcomes of multiple conditions and aging and their underlying biological mechanisms with a socioecological model framework. Develop multilevel conceptual frameworks to study the intersection of ethnicity, culture, socioeconomic position, gender roles, and socioecological determinants on health.<br>Use an exposome approach to study environmental influences and biological response across the life span. Incorporate early-life and cumulative measures of occupational and neighborhood exposures, including those in the country of origin for more recent immigrants. |
| Develop a survey repository:<br>Establish centralized repositories of standard or novel surveys and instruments (in multiple languages). These include tools for measuring acculturation, immigration factors, and social/interpersonal measures (discrimination, social support, neighborhood cohesion). (Examples of existing repositories include the NIH PhenX toolkit or the Common Data Elements repository.)<br>Develop, test, and validate dietary assessment tools, mental health instruments, and cognitive function measures in specific AsA and NHPI ethnic groups. |
| Biobank:<br>Create biobanks that are linked to phenotypic and clinical data (EHR) to enable genomic and other omics to advance biological discoveries unique to AsA and NHPI populations. |
| Methods studies in AsA and NHPI:<br>Build statistical methods for estimating annual AsA and NHPI population sizes to generate annual rates for monitoring of trends and patterns to inform prevention, resource allocation, and patient care. |
| **III. Leverage and enhance existing data sources.**<br>*Expand AsA and NHPI inclusion and ethnic group identification in ongoing cohorts, EHRs, national and state surveys, and other data sources, with appropriate data disaggregation.* |
| Coding standardization:<br>Standardize coding methods for AsA and NHPI subgroups (expanding ethnic categorization and nativity) in federal and state data sets, EHR data, disease registries, and claims data sets.<br>Leverage electronic data resources for screening and recruitment of study participants, and link data with various data sets for exposure and outcome measures. |
| Secondary data analysis:<br>Conduct secondary analyses of existing data sets (e.g., national cancer registry systems, California Health Interview Survey, NHANES, NHPI National<br>Health Interview Survey); carry out pooled analyses from existing cohorts and ongoing cohorts; add ancillary studies to ongoing cohorts. |

| Approaches and Specific Steps |
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| **IV. Incorporate novel technologies for exposure assessment and clinical evaluation**.<br>*Leverage modern imaging techniques and digital technology for exposure and outcome assessment to advance health research in AsA and NHPI populations*.<br>Imaging: Use the most appropriate imaging technologies: DXA, MRI, or CT, to accurately quantify body composition; ultrasonography and FibroScan for NAFLD; advanced low-dose CT for lung disease and cardiac plaque; echo and MRI for cardiac function.<br>Sensor technology: Deploy wearable biosensing and mobile health technology to capture objective, real-time and continuous data for more accurate and reliable measurement of exposures.<br>Omics: Use modern omics approaches to combine genomic, transcriptomic, proteomic, and metabolomic data with rich phenotypic, environmental, and behavioral data. |

AsA = Asian American; CT = computed tomography; DXA = dual-energy X-ray absorptiometry; echo = echocardiography; EHR = electronic health record; MRI = magnetic resonance imaging; NAFLD = nonalcoholic fatty liver disease; NHANES = National Health and Nutrition Examination Survey; NHPI = Native Hawaiian and Pacific Islander.

* The proposed methods and specific steps are not mutually exclusive and may be complementary and synergistic with other ongoing studies.