Kidney Cancer Study
Merrimack, NH
Phase 3 Feasibility Study
Pilot Study Ancillary Report
May 2026

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https://www.dhhs.nh.gov/programs-services/disease-prevention/cancer/cancer-concerns-and-investigations/investigation-kidney

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EXECUTIVE SUMMARY

Building upon the other major study components of the Merrimack Kidney Cancer Study as described in the Kidney Cancer Study Merrimack, NH Phase 3 Feasibility Study Final Report (available at https://geiselmed.dartmouth.edu/nhscr/mkc/), a pilot study was conducted to demonstrate the feasibility of enrolling study participants and engaging NH residents in relevant research activities. The pilot study was not designed to identify any statistically significant kidney cancer risk factors, but rather to inform refinement of the protocol for a potential larger study in the future. Overall, the pilot study was highly successful and helped to identify several important considerations for planning a future study. The enrollment goals for the pilot study were exceeded, and participants completed the pilot study survey showing that the study methods can be scaled up for a larger study. Although the pilot study suggests that it is feasible to collect biological samples, the study team found that an extended timeline to work with participants on sample collection would be beneficial. For a future study, the team will consider whether traditional phlebotomy (blood draw) techniques may be more feasible, because less than half of participants invited to provide self-collected blood samples ultimately returned a sample. Alternate biomarkers such as urine and hair were not pilot tested due to time constraints, but they can additionally be incorporated into a larger study to extend the range of potential environmental exposures studied. Additional biospecimens will need to be thoughtfully integrated into any future study given the moderate response rate for self-collected blood samples and hesitance of participants to provide toenail clippings in the pilot study. Preliminary assessments in this pilot study suggest that linkage of private well testing data from the Environmental Monitoring Database maintained by NH is conceptually feasible. However, a full linkage will be complex, requiring consideration of changes in water contamination over time and addressing that participants likely lived in several different homes during the exposure window of interest. The pilot study provides useful findings to support a grant application for a larger study in the future through federal agencies and foundations. However, the potential barriers to the acquisition of such funding that were identified in the NH Phase 3 Feasibility Study Final Report remain.

PILOT STUDY OBJECTIVES

The primary goal of the pilot study was to demonstrate feasibility, including the numbers and proportions of participants originating from different advertising methods (e.g., clinic, flyers, UNH Survey Panel) and descriptive analyses of the survey data including counts and proportions. We also calculated odds ratios and confidence intervals comparing prevalence of known demographic risk factors among cases and controls. These pilot data are not expected to have sufficient power to identify any statistically significant kidney cancer risk factors. However, the information gained could be informative for refining a protocol for a larger future study that will be designed to identify potential causal factors for kidney cancer.

PILOT STUDY DESIGN

Based on feedback from the Scientific Advisory Board, the Dartmouth team designed a pilot case-control study, with a primary objective to determine the feasibility of enrolling participants with or without renal cell carcinoma, and collecting data, to inform a future definitive study that will aim to identify potential factors contributing to the observed excess of kidney cancer cases in the Merrimack, NH area. The scientific advisory board advised that a sample size of 50 would likely be sufficient for our purposes. The Dartmouth team chose to aim for a sample size of 70-100. The Steering Committee approved the plan for the pilot study on February 5, 2025. The Community Advisory Board also gave feedback on recruitment strategies for the pilot study.

A case-control study design was chosen for the pilot study due to the design efficiency for studying rare diseases, ability to explore associations of several potential kidney cancer risk factors with risk of kidney cancer in the study area, and utility for the goal of hypothesis generation. Additional considerations for the design of the pilot study have been previously described in the Kidney Cancer Study, Merrimack, New Hampshire, Phase 3 Feasibility Study Final Report. [1]

Case definition

The overarching findings from the Phase III Feasibility Study suggest that a larger future study should likely focus on cases of clear cell carcinoma. However, for the pilot study, patients with any type of kidney cancer were able to participate if they met the other eligibility criteria for inclusion in the study. This broader case definition was chosen purposefully to allow the team to assess the difficulty of recruiting cases with specific subtypes of kidney cancer in a future study.

[1] Kidney Cancer Study, Merrimack, New Hampshire, Phase 3 Feasibility Study Final Report – 2025. Available at https://geiselmed.dartmouth.edu/nhscr/mkc/.

Protection of Human Subjects

- The team met with representatives from the Dartmouth Committee for the Protection of Human Subjects (CPHS) on February 19, 2025, and determined that the proposed protocol met the criteria for expedited review by the Institutional Review Board (IRB).
- Scientific review by the Department of Epidemiology was completed on March 4, 2025, and the Clinical Cancer Review Committee approved the protocol on April 8, 2025.
- CPHS approved the protocol on April 16, 2025 (CPHS Study # STUDY00033330), and a Certificate of Confidentiality was obtained from the National Institutes of Health on April 21, 2025 (CC-OD-25-7221).
- A modification of the study protocol to allow for self-collection of blood and toenail samples was submitted on May 30, 2025, and approved on June 12, 2025 (CPHS #MOD00013123).

Eligibility and Recruitment Goals

The Dartmouth team planned a pilot study involving adult residents of NH, aged 18 years and older with and without a diagnosis of kidney cancer. Recruitment efforts were focused on participants who currently or previously lived or worked for at least 12 months in the towns of Merrimack, Amherst, Bedford, Hollis, Hudson, Litchfield, Londonderry, Manchester, and Nashua, NH (9-town area), but all NH residents were eligible.

The target sample size was between 70 to 100 participants for the survey and a subset of ten to twenty participants providing self-collection blood samples and/or toenail clippings. Members of the Scientific Advisory Board advised the team that as few as 50 participants would likely be informative but supported the target sample size of 70-100 participants.

Overview of Pilot Study Activities

Participants were invited to complete a survey capturing information on demographic variables such as height and weight, existing health comorbidities, personal medical history of familial diagnoses, lifestyle factors such as smoking and physical activity, as well as environmental and occupational exposures, residential history and drinking water sources. Where possible, we linked current address to drinking water testing information available from the Environmental Monitoring Database maintained by NHDES. Additionally, we assessed willingness to participate in other study activities in order to inform efforts to plan a larger future study; these included water sample collection, providing access to medical records, blood collection, urine collection, or - for participants with a history of kidney cancer - requesting tumor tissue when excess exists after use

in clinical care, for potential future study use. We also asked participants if they would be willing to be contacted to participate in these kinds of additional study activities in the future.

A subset of participants who indicated willingness to provide samples were considered to provide finger prick self-collection blood sample and/or toenail clippings. In collaboration with the Steering Committee and Scientific Advisory Board, additional sample collection was considered including tap water, urine, and dried blood spots. These additional activities were ultimately deemed infeasible for the study timeline and remaining budget, though a future larger study could potentially incorporate these activities.

PILOT STUDY RESULTS

More than 3,000 responses were received on the interest form. The following validation techniques were employed to ascertain that responses originated from a human versus a bot: White Pages were used to verify information provided, multiple responses sent from the same IP address were removed, responses that originated from a longitude and latitude outside of New Hampshire were removed, and phone number verification was used if doubt remained. Through this process, we identified 140 valid and eligible participants and invited them to complete the survey. The University of New Hampshire Survey Center implemented a survey for the Dartmouth College Geisel School of Medicine to gain insight into Merrimack area residents' views of environmental contaminants, potential risk factors for cancer, and interest in participating in future research. One hundred five individuals (105) completed it between May 30 and July 2, 2025, resulting in a response rate of 75%.

Pilot Study Survey

We received 105 completed surveys (response rate=75%) and 8 partially completed surveys. Participants were recruited via social media/online news articles (43.8%), referral by friends or family members (31.8%), flyers posted in public spaces (12.5%), email or newsletters (6.3%), or from a newspaper ad (6.3%). There were 9 cases of kidney cancer among the 105 participants. Because of the small number of cases, most of the data are presented below as an aggregate of all participants. Likewise, percentages <5% are suppressed to protect participant privacy.

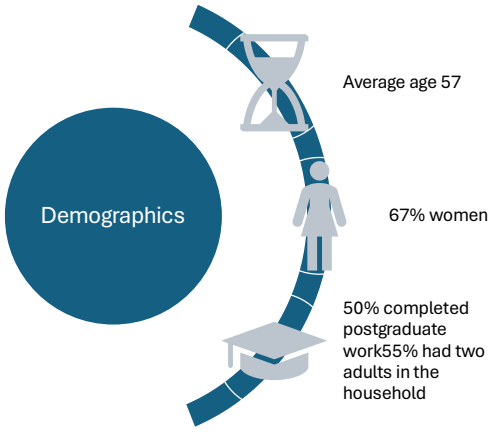

Figure 1. Demographics at a Glance

Participant Demographics and Characteristics

Age, sex, and education

The average age of respondents was 56 and the median age was 57. Approximately 9% of respondents were between the ages of 18 and 34, 25% were between 35 and 49, 28% were between 50 and 64, and 32%

were 65 or older (7% did not provide their age). Two-thirds of participants (67%) were women and 32% were men. Ninety-seven percent of participants identified as Caucasian or White, reflective of the underlying racial/ethnic distribution in the region. Half of participants (50%) had completed postgraduate work, 30% were college graduates, 16% had completed some college education, and 5% had completed technical school, high school, or earned their G.E.D (Figure 1).

Household characteristics

Nearly three in four respondents (73%) had no children living in their household, while 10% had one and 17% had two or more. Eighteen percent of respondents were the only adult in their household, 55% had two adults in their household, 14% had three, 12% had four or more. Seven percent of respondents had a household income less than $45,000, 13% had a household income between $45,000 and $74,999, 10% had a household income between $75,000 and $99,999, 29% had a household income between $100,000 and $149,999, 10% had a household income between $150,000 and $199,999, and 13% had a household income of $200,000 and over. Eighteen percent preferred not to disclose their household income or were unsure of their household income. Nine in ten respondents (90%) owned their home and 9% rented their home (Figure 2). Twelve percent of respondents reported themselves or someone in their household was a veteran or member of the armed forces.

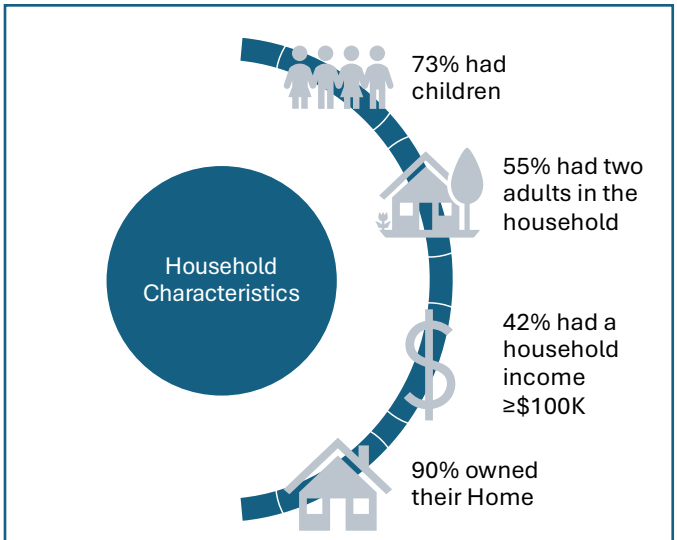

Figure 2. Household Characteristics at a Glance

Employment and Occupational History

Fifty-eight percent of respondents were currently employed, 37% were not currently employed but had at least one job in the past 20 years, and 5% were not currently employed and had not been in the last 20 years. One-third of respondents had just one job in the past 20 years while 30% had two jobs in this time, 24% had between 3 and 5 jobs, and 7% had more than 5 jobs.

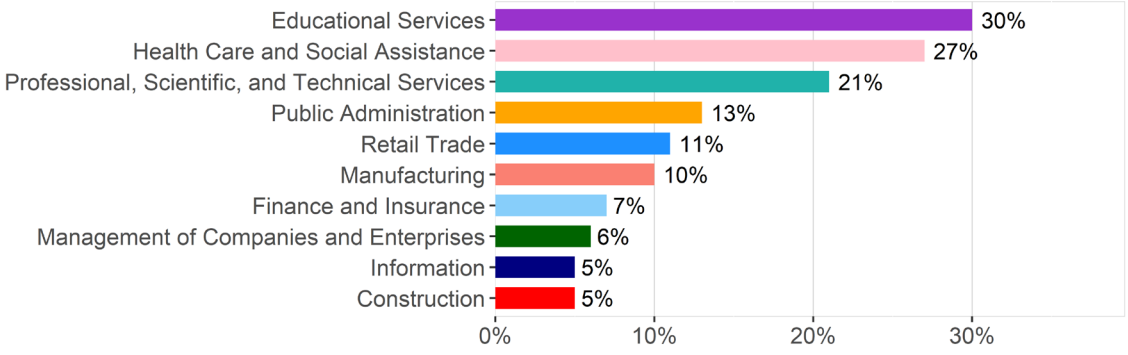

Figure 3: Job industry in the past twenty years among respondents reporting at least one job in the past 20 years (n=100) [Categories with <5% not shown]

Among respondents who had at least one job in the past 20 years (n=100), 30% had at least one job in educational services, while 27% had a job in health care and social assistance, and 21% had a job in professional, scientific, and technical services (Figure 3).

Of the 249 jobs held by respondents, 22% were in educational services, 20% were in health care and social assistance, and 15% were in professional, scientific, and technical services, 9% in manufacturing, and 8% in public administration. Less than 5% had jobs in each of the following: retail trade, finance and insurance, construction, management of companies and enterprises, information, other services, accommodation and food services, transportation and warehousing, arts, entertainment, and recreation, real estate rental and leasing, mining, or agriculture, forestry, fishing, and hunting.

Lifestyle factors

In the week before the survey, 60% of participants reported that they had engaged in vigorous physical activity at least once, 75% reported moderate physical activity at least once, and 90% reported that they walked for at least ten minutes at least once (Figure 4).

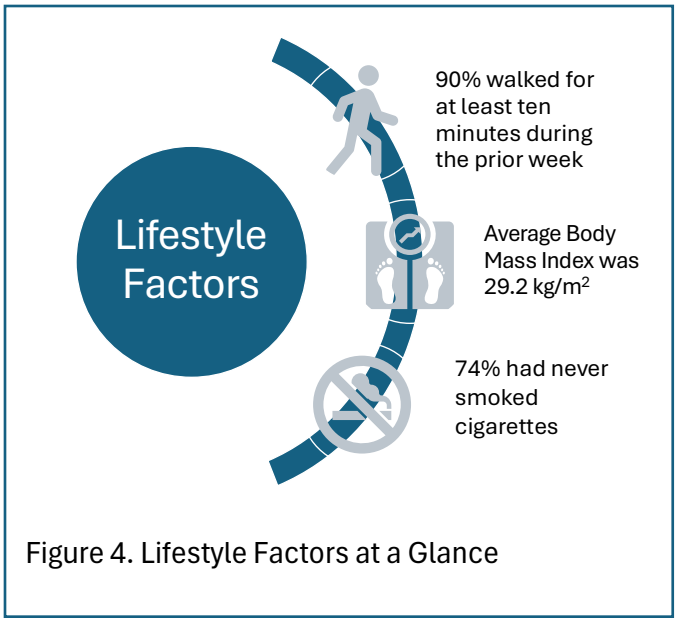

Figure 4. Lifestyle Factors at a Glance

The average height for a respondent was 5 feet, 6 inches, and the average weight was 182 pounds. The average body mass index (BMI) was 29.2 kg/m^2 (Table 1).

In terms of diet, participants reported that they ate vegetables (58%), fruit (55%), peanut butter and nuts (35%), full-fat dairy products (32%), whole grain bread, rice, pasta, or cereal (28%) on a daily basis. The majority of participants consumed soda, soft drinks, sports or energy drinks (75%), beer, wine, or liquor (53%), and processed meats (51%) less than once per week.

Among participants, 26% reported that they had smoked at least 100 cigarettes in their lifetime while 11% reported that they still smoke cigarettes on a regular basis (Figure 4). Only 6% had tried electronic nicotine products. The majority of participants (70%) say they were exposed to passive smoking (5 days per week or more) at some point in their lives, while 38% report 10+ years of exposure.

Personal Health and Cancer History

The largest share of respondents reported that their health was good (46%), while some think that their health was excellent (12%) or very good (32%). The health issues that were most frequently

reported were being told by a doctor that they were overweight (50%), obese (29%), or had high blood pressure (36%) (Figure 5).

Among participants, 23% were diagnosed with cancer at some point, with the most common types being kidney/renal (38%), melanoma (21%), or prostate cancer (13%). Among those with a history of kidney cancer, only 33% were willing to be contacted by the study team for permission to obtain and store tumor tissue samples that were collected during the course of their clinical care (56% were unsure and 11% were unwilling).

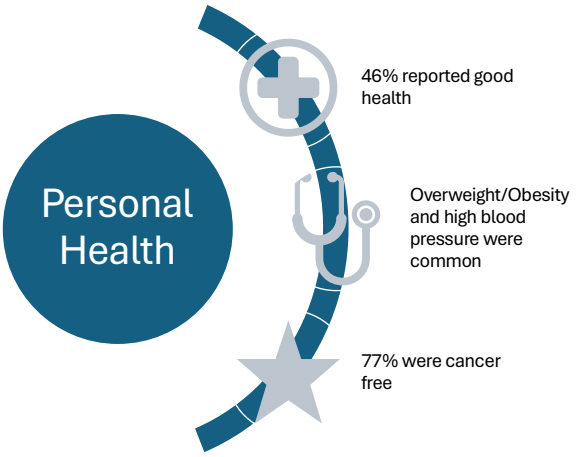

Figure 5. Personal Health at a Glance

Many participants (66%) reported that an immediate family member had been diagnosed with cancer. Among these participants, breast (30%), melanoma (23%), and colon or rectum cancer (22%) were the most common types of cancer reported for their family member.

Environmental Factors Influencing Health

Participants reported their level of concern about the influence of the environment on their health (Figure 6), their level of knowledge about environmental factors influencing health (Figure 7), and their level of concern about specific environmental risk factors (Figure 8). The majority of respondents (79%) reported they were very or somewhat concerned about environmental contaminants affecting farm-produced food. About two-thirds of participants expressed concern about environmental contaminants affecting wildlife (68%), developing future health problems due to something in the environment (67%), and the environment affecting the health of them or their immediate family. Respondents were most familiar with contaminants such as lead (76%), PFAS (76%), asbestos (73%), pesticides (72%), and radon (63%), but less familiar with arsenic (48%), PCBs (44%), uranium (31%), cadmium (25%), vinyl chloride (23%), and trichloroethylene (22%). Among those familiar with contaminants, most were very or somewhat concerned about PFAS (75%) and pesticides (73%) while fewer were concerned about cadmium (29%) and uranium (29%).

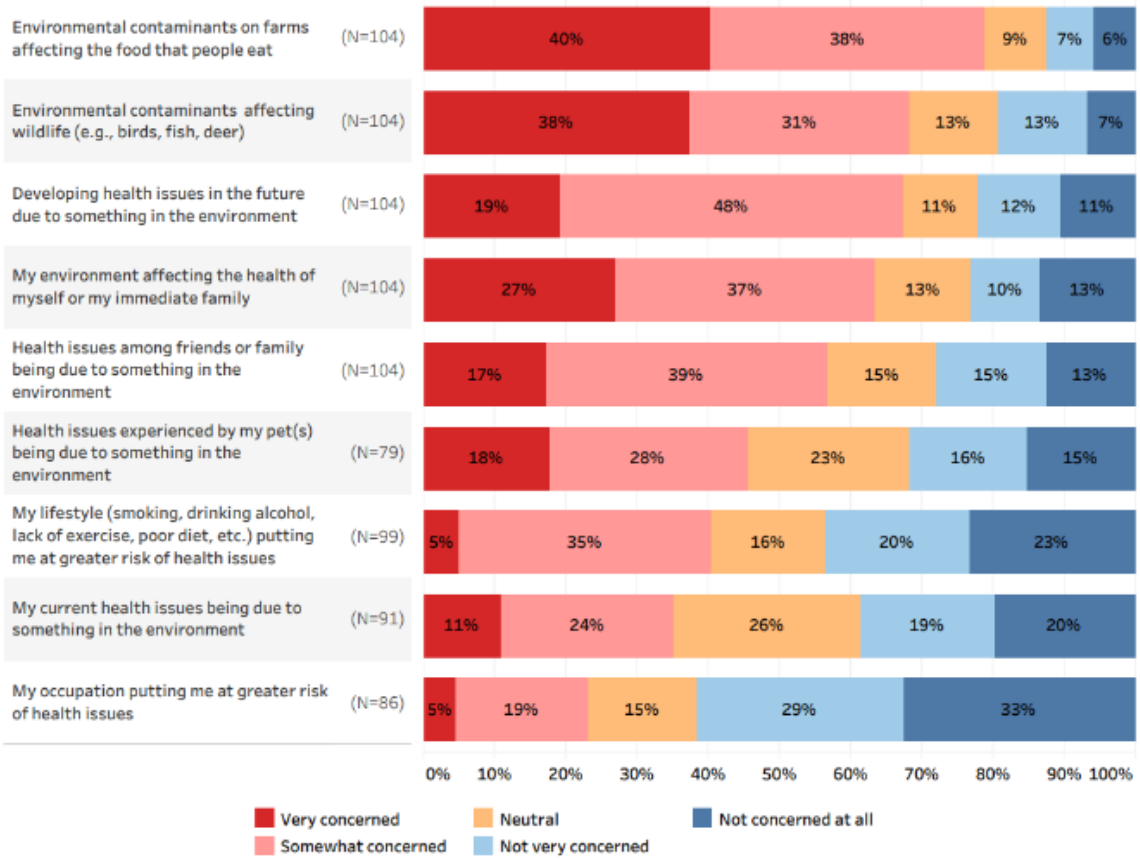

Figure 6. Reported Level of Concern on Environment Factors Influencing Health

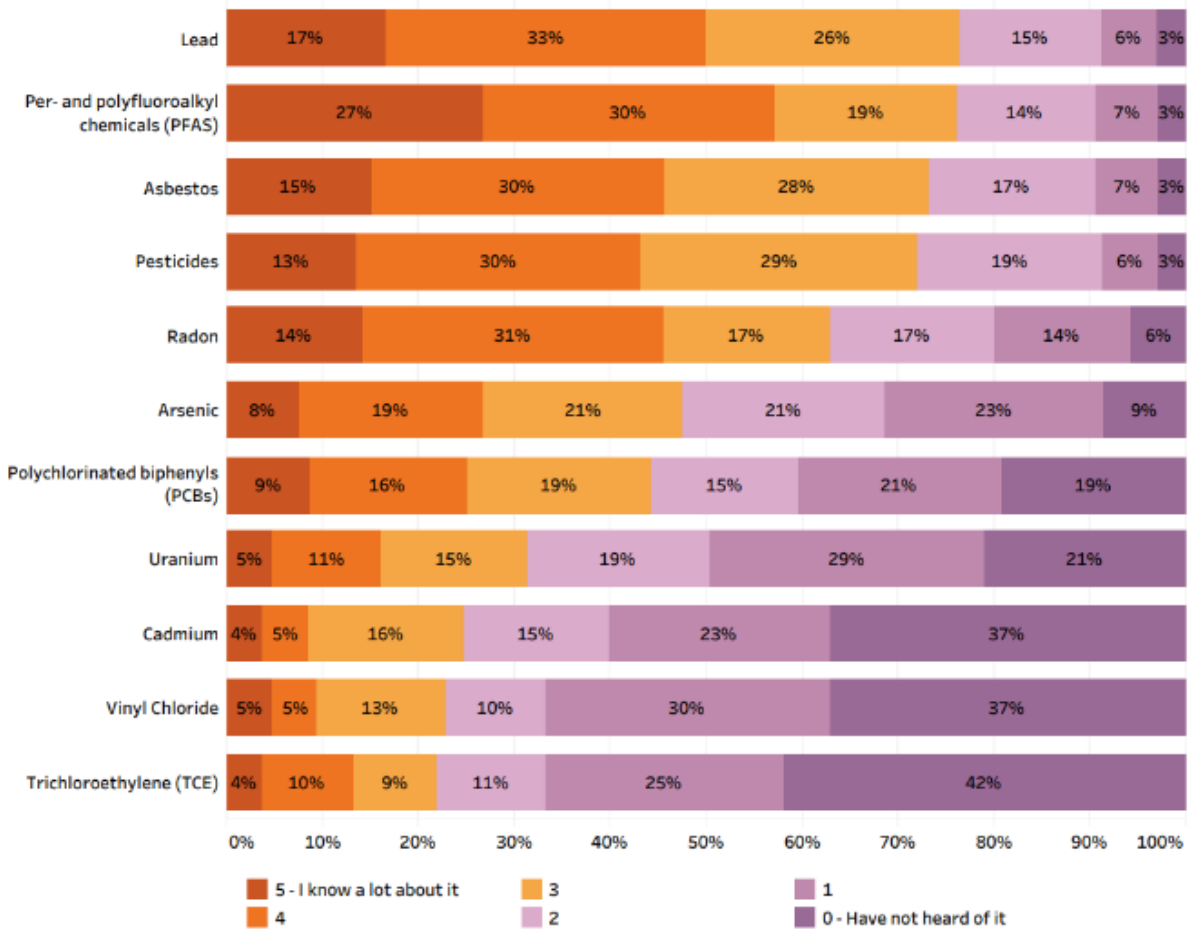

Figure 7. Reported Knowledge about Environmental Factors and Health

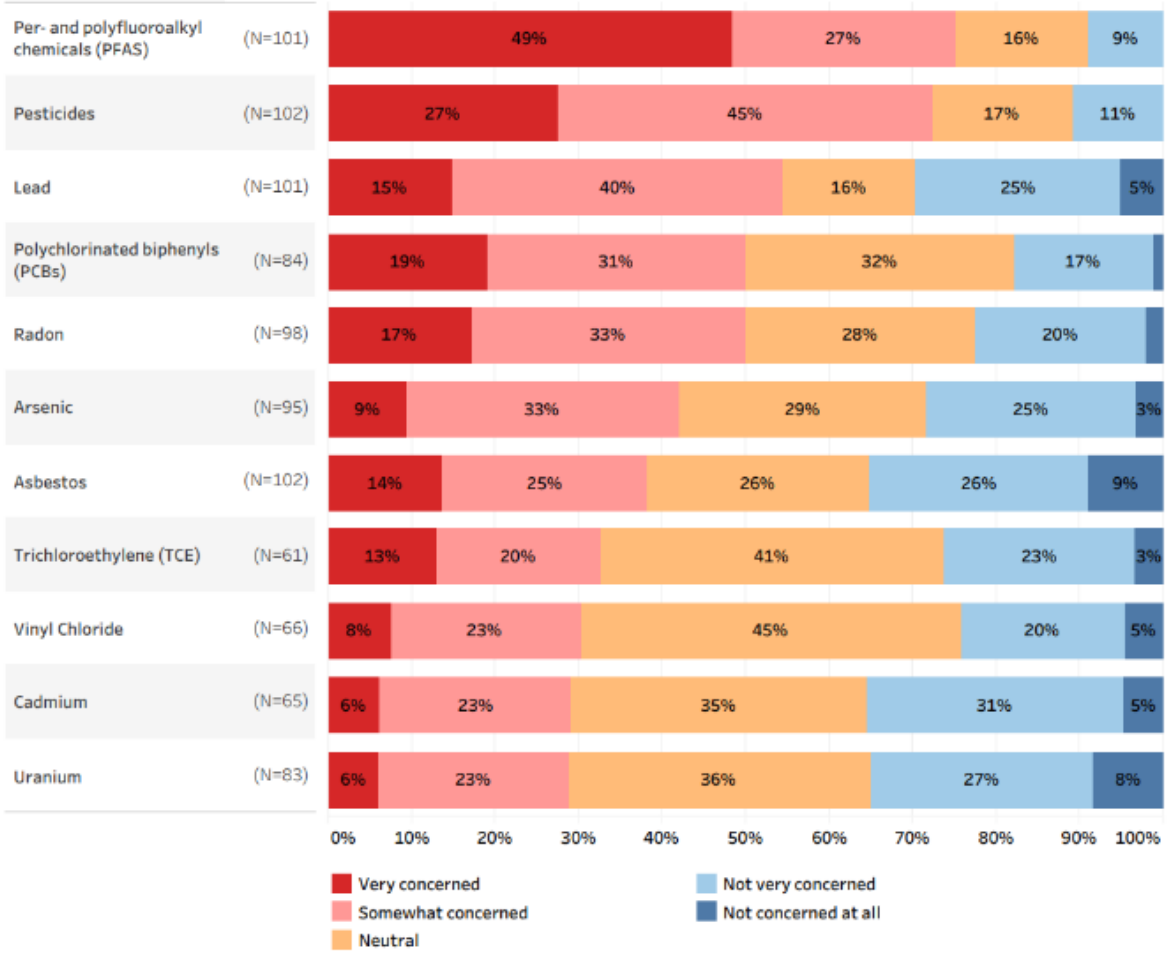

Figure 8. Reported Level of Concern about Possible Influence of Specific Environmental Exposures on Own Health or the Health of Family Members

Residential History and Water Sources

Nearly all respondents (93%) had lived in their current home for at least 24 months. The largest share (41%) lived in the town of Merrimack, with many others living in nearby towns. 65% had a public water source at their home, while 31% had a private one. Many respondents say there was a period of time at their current home where they used bottled water (35%), a pitcher filter or filter at the faucet (30%), or a whole home filtration system (14%), rather than drinking directly from the faucet. Among those with private wells, 48% were tested for arsenic in the past five years and 45% were tested for PFAS.

Linkage to Water Testing Data

Staff from the Drinking Water Quality Program at NH DES manage an extensive database of well-water testing data throughout New Hampshire. A review of these data indicates that it may be feasible to match addresses provided in a residential history to drinking water testing records to help inform exposure models in future research. NH DES shared a large data set including the private well PFAS data available in the Environmental Monitoring Database, covering test dates between 2016 – 2025 (75% of the data were from 2020-2025), and for the 9-town area (Amherst, Bedford, Hollis, Hudson, Litchfield, Londonderry, Manchester, Merrimack, and Nashua). The data provided was then compared to the Merrimack Kidney Cancer Pilot Study participant's residential history. We linked current address information to drinking water testing information available from NHDES where possible. The NH DES provided private well PFAS analyses available in the Environmental Monitoring Database for the 9-town area. Among the 35 participants currently living at a residence with a private well, we were able to locate private water testing records for 24 of these residences (i.e., 68.6% matched to the database). Preparing the data for a research study would require a substantial investment of time and expertise, as a full linkage would need to incorporate information about years lived at the residence, timing of testing, and water usage habits of the residents. Nonetheless, this initial linkage indicates that the publicly available data are potentially useful for exposure assessment in a larger future study.

Feasibility of Potential Future Study Activities

The majority (95%) of respondents indicated that they were almost certainly or probably willing to provide a water sample from their kitchen tap in future research, 90% would provide a urine sample, 87% would provide a blood sample, and 68% would allow researchers to access their medical records. Only 33% of those who had kidney or renal cancer would be willing to let the research team obtain a small piece of the tumor.

Biological Samples

Biospecimens were collected from a subset of participants that reported a willingness to provide a blood sample on the study survey. A subset of 40 participants was invited to provide a self-collected blood sample using a finger prick and requiring minimal sample volumes. The self-collection kit included lancets and instructions for use, and all participants were offered the opportunity to have a virtual study visit with the study coordinator if desired. All participants who

had a current of previous kidney cancer diagnosis were invited to provide a blood sample, and one or two age- (within 5 years) and sex-matched controls were also invited to provide blood sample. All individuals invited to provide a blood sample were also invited to provide toenail clippings to be used for future assessment of metals and metalloids.

Although 80% of participants indicated a willingness to provide a blood sample for future research, fewer than half of the pilot study participants invited to provide a blood sample chose to return a biospecimen to the study team. Among the 40 participants invited to provide blood samples, 16 (40%) consented to do so and 14 returned completed blood collection kits. Three participants declined to provide biospecimens, and 21 did not respond. Ten participants returned toenail clippings, whereas three participants expressed discomfort with providing toenail clippings and one had a medical condition that prevented collection. Individual results were summarized and returned to participants who provided a biospecimen for PFAS analysis in March 2026. Aggregate PFAS results are presented in this report.

Kits were shipped to Eurofins environmental laboratory to quantify PFAS in the 14 blood samples using liquid chromatography tandem mass spectrometry and online solid-phase extraction.[2] This assay included a list of analytes from CDC used in the National Health and Nutrition Examination Survey (NHANES) and Eurofin's expanded analyte list of PFAS. Reports included concentrations of 44 PFAS analytes (PFOA and PFOS were analyzed for linear and branched analytes and then added together for Total PFOA and Total PFOS presented here). There were 4 PFAS that were detected in more than 85% of the samples (Total PFOA, Total PFOS, PFHxS, PFNA) and 5 PFAS that were detected in less than 50% of samples (PFOSA, PFUnA, PFBA, NMeFOSAA, and PFDA). The remaining 33 PFAS were below the detection limit in all samples.[3]

Median values for Total PFOA and PFNA were slightly higher than the general population as represented by latest values available from NHANES in 2015-2016 (Table 2). Values from NHANES reflect exposure in the general population of the United States. Total PFOS and PFHxS median serum equivalent concentrations were slightly higher than NHANES.

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[2] Carignan CC, Bauer RA, Patterson A, Phomsopha T, Redman E, Stapleton HM, Higgins CP. Self-Collection Blood Test for PFASs: Comparing Volumetric Microsamplers with a Traditional Serum Approach. Environ Sci Technol. 2023 May 30;57(21):7950-7957. doi: 10.1021/acs.est.2c09852. Epub 2023 May 15. PMID: 37189231; PMCID: PMC10233751.

[3]The following PFAS were not detected in the pilot study blood samples: 9CI-PF3ONS, 4,8-Dioxa-3H-perfluorononanoic acid (ADONA), HFPO-DA (GenX), Perfluoroheptanesulfonic acid (PFHpS), Perfluorohexanoic acid (PFHxA), Perfluoroheptanoic acid (PFHpA), Perfluorododecanoic acid (PFDOA), Perfluorotridecanoic acid (PFTrDA), Perfluorotetradecanoic acid (PFTeDA), Perfluoro-n-hexadecanoic acid (PFHXDA), Perfluorobutanesulfonic acid (PFBS), Perfluoropentanesulfonic acid (PFPeS), Perfluorononanesulfonic acid (PFNS), Perfluorodecanesulfonic acid (PFDS), Perfluorododecanesulfonic acid (PFDOS), NEIFOSAA, 4:2 FTS, 8:2 FTS, 10:2 FTS, 11CI-PF3OUdS, 5:3 FTCA, 7:3 FTCA, 6:2 FTCA, 6:2 FTUCA, NFDHA, PFMBA, PFEESA, 8:2 FTCA, 8:2 FTUCA, PFECHS, PFPE-1, PFO5DA, Hydro-PS Acid).

Table 2. Summary of Serum Equivalent PFAS Concentrations (ng/mL) (n=14)

PFAS	*% Detected*	*Mean (SD)*	*Median (25th, 75th percentile)*	*NHANES Median (95%CI)* [a]
Total PFOA	93%	2.22 (1.03)	2.40 (1.48, 2.80)	1.57 (1.47-1.77)
Total PFOS	100%	4.11 (2.62)	3.23 (2.09, 5.89)	4.80 (4.40-5.30)
PFHxS	100%	1.10 (0.78)	0.84 (0.59, 1.43)	1.20 (1.10-1.40)
PFNA	86%	0.87 (0.34)	0.76 (0.62, 1.14)	0.60 (0.50-0.60)
NASEM PFAS Sum [b]	-	8.2 (4.5)	6.9 (4.8, 11.5)	-

[a] Serum from NHANES from 2015-2016[4]

[b] National Academies of Sciences, Engineering, and Medicine (NASEM) PFAS Sum reflects the sum of 7 PFAS (MeFOSAA, PFHxS, Total PFOA, PFDA, PFUnDA, Total PFOS, and PFNA) detected in blood.

Data not shown for the following PFAS with low detection: PFOSA (50%), PFUnA (14%) and PFbA, NMeFOSAA, and PFDA (7%) and the following PFAS, which were not detected in the pilot study blood samples: 9Cl-PF3ONS, 4,8-Dioxa-3H-perfluorononanoic acid (ADONA), HFPO-DA (GenX), Perfluoroheptanesulfonic acid (PFHpS), Perfluorohexanoic acid (PFHxA), Perfluoroheptanoic acid (PFHpA), Perfluorododecanoic acid (PFDOA), Perfluorotridecanoic acid (PFTrDA), Perfluorotetradecanoic acid (PFTeDA), Perfluoro-n-hexadecanoic acid (PFHXDA), Perfluorobutanesulfonic acid (PFBS), Perfluoropentanesulfonic acid (PFPeS), Perfluorononanesulfonic acid (PFNS), Perfluorodecanesulfonic acid (PFDS), Perfluorododecanesulfonic acid (PFDOS), NEtFOSAA, 4:2 FTS, 8:2 FTS, 10:2 FTS, 11Cl-PF3OUdS, 5:3 FTCA, 7:3 FTCA, 6:2 FTCA, 6:2 FTUCA, NFDHA, PFMBA, PFEESA, 8:2 FTCA, 8:2 FTUCA, PFECHS, PFPE-1, PFO5DA, Hydro-PS Acid).

The National Academies of Sciences, Engineering, and Medicine (NASEM) created guidance for PFAS testing and clinical care for patients exposed to PFAS.[5] The sum of seven PFAS (MeFOSAA, PFHxS, Total PFOA, PFDA, PFUnDA, Total PFOS, and PFNA) detected in blood was calculated as NASEM Total Value and can be compared to threshold values that may inform clinical care. The NASEM guidelines suggest that the total sum of PFAS can be categorized into three levels: below 2 nanograms/milliliter (ng/mL) (no anticipated adverse health effects),>2 to <20 ng/mL (possible adverse health effects), and above 20 μg/L (increased risk of potential adverse health effects). Among the pilot study samples, the majority of samples (93%) were in the middle category between 2-20 ng/mL with the potential for adverse effects. The NASEM guidelines also recommend reduction of exposures at this concentration. It is important to note that the Agency for Toxic Substances and Disease Registry (ATSDR) did not adopt these guidelines for integration into clinical care;[6] however, the categories remain a useful framework to provide context for the concentrations of PFAS observed in the pilot study.

[4] CDC Biomonitoring Table for Environmental Chemicals, 2024

[5] NASEM Guidance on PFAS Exposure, Testing, and Clinical Follow-Up, 2022

[6] ATSDR PFAS Information for Clinicians: Factsheet, 2024

SUMMARY OF PILOT STUDY KEY FINDINGS

- Enrollment goals for this pilot study were exceeded, and participants completed the pilot study survey reinforcing that the survey methods can be confidently scaled up for a larger study.
- It is feasible to collect biological samples, but more time is needed to work with participants on sample collection than was possible during the pilot study. Traditional phlebotomy (blood draw) techniques may be more feasible in a larger study. Alternate biomarkers such as urine and hair can additionally be incorporated into a larger study to extend the range of potential environmental exposures studied.
- Our preliminary assessments suggest that linkage of private well testing data from Environmental Monitoring Database is feasible but would be more complex and time consuming for use in future research.
- The Dartmouth team can use the findings of the pilot study in a grant application to justify the need for a bigger study in the future through federal agencies and foundations. Reservations about the current funding landscape described in the NH Phase 3 Feasibility Study Final Report remain.