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## Children's Environmental Health and Disaster Resilience in Puerto Rico and the U.S. Virgin Islands

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### Abstract

The environment plays a significant role in the global burden of disease for children. Climate-related disasters such as the 2017 Atlantic hurricane season are increasingly contributing to this burden. United Nations designated Small Island Developing States (SIDS) like Puerto Rico and the U.S. Virgin Islands are particularly at risk due to environmental health hazards caused by natural disasters, and health care structure vulnerabilities. United Nations' Sustainable Development Goals (UN SDG), specifically UN SDG 3, 13 and 17, focus on climate impacts via promotion of health preparedness and building partnerships between different sectors of society, respectively. The Pediatric Environmental Health Specialty Unit's (PEHSU) work is consistent with these most notably via the delivery of environmental health services along with training nurses, doctors, and other health professionals, formation of partnerships and linking resources. Therefore, training a diverse array of health professionals and linking these groups to relevant community resources is of utmost importance and has the potential to enhance the effective management and early prevention of top environmental health (EH) risks. Nursing is identified as a key health sector to engage for this initiative. This article describes the work of the Federal Region 2 PEHSU in Puerto Rico and the U.S. Virgin Islands that supports health professionals' knowledge building, development of environmental health services, and promotion of wide scale access to such services for children and families. The PEHSU's work is consistent with these most notably with regards to the delivery of environmental health services in pediatrics

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Author Statement

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## Keywords

pediatric environmental health; sustainable development; disaster resilience; partnerships; nursing sector mapping; Puerto Rico and U.S. Virgin Islands

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## Introduction

A child's environment plays a critical role in his or her health and development. During early fetal and childhood periods, children are more vulnerable to harmful environmental exposures that can result in lifelong repercussions. A quarter of the global burden of diseases, including non-communicable diseases (NCD), can be attributed to early exposures to environmental factors. (Leith Sly and Carpenter 2012). In addition, climate change is worsening the risks to the well-being of children, a subpopulation that will disproportionately bear the burden of climate-related disease through mechanisms such as heat-related injuries and illness, asthma, allergies and neurodevelopmental and mental health disorders (Sheffield and Landrigan 2011).

The importance and meaning of children's environmental health (CEH) and the corresponding clinical field called pediatric environmental health (PEH) has changed over time. Over the past century, many gains have been made against childhood infectious diseases. However, non-communicable diseases (NCD) – such as asthma, obesity, and neurodevelopmental disorders - have emerged as a large and growing threat dubbed the “new pediatric morbidity” with environmental exposures playing an important role (Landrigan and Etzel 2014). Further, the growing burden of NCD, combined with a changing climate, has a compounding effect for developing countries particularly in resource limited or geographically remote regions of the world such as parts of Latin America and the Caribbean (Leith Sly and Carpenter 2012). Two populations particularly vulnerable to environmental health hazards are the children living in Puerto Rico (PR) and the U.S. Virgin Islands (USVI), two of the 52 developing countries and territories designated Small Island Developing States (SIDS) by the United Nations, and affected by the brutal 2017 Atlantic hurricane season. The 2017 Hurricanes Irma and Maria created a public health emergency, exposed the vulnerabilities of these SIDS' health care systems and infrastructure, and raised public awareness of the need for resilience. The concept of resilience has emerged as a prominent idea in PEH. While no universal definition exists, resilience is generally defined as having a positive outcome despite the presence of negative factors (Aburn et al 2016). Resilience can exist in the presence of short-term and/or long-term or chronic stressors, including those from the chemical, physical, psychosocial or other environments. Specifically, disaster resilience is defined as the ability of individuals, communities, organizations and states to adapt to and recover from hazards, shocks or stresses without compromising long-term prospects for development (Combaz 2014).

To build resilience and to support specific pediatric environmental health concerns, the U.S. federal government has taken specific action over the last couple of decades. In response to calls for increased environmental health (EH) training for health care providers, the national network of Pediatric Environmental Health Specialty Units (PEHSU) was launched

in the late 1990s to address the gap in medical expertise in children's environmental health (Paulson et al 2009). The mission of the PEHSU program is now to improve reproductive and children's health by leading the integration of environmental health into clinical care and public health while supporting communities to address historical injustices and ongoing environmental racism and address the existential threat of climate change. This PEHSU network is divided into ten federal regions. The PEHSU serving Puerto Rico and USVI is the Federal Region 2 PEHSU that also serves New Jersey and New York. Having developed over almost two decades, the regional PEHSUs are well positioned to address on-going pediatric environmental health needs in scalable and sustainable ways particularly as climate events increasingly aggravate environmental hazards.

Consistent with the United Nations' Sustainable Development Goal (UN SDG) 13 on climate impacts, promotion of health is needed to address a continuum of healthcare delivery needs and potential health risks (Morton et al 2017). By extension, public health and clinical service initiatives – such as healthcare detailing visits, clinic site visits, community presentations and the distribution of action kits to health providers led by the PEHSU - should incorporate the social determinants of health (e.g. by identifying and acting on aspects that build resilience) into each sector's practice (Garg et al 2012). Further, the 2017 hurricanes revealed the importance of creating alliances and networks with and within these SIDS, consistent with UN SDG 17 on partnership-building between governments, academia, and other civil sector entities is essential, particularly where sheltering in place during disasters is likely necessary (Morton et al 2017). Lastly, and most fundamentally, the PEHSU work supports UN SDG 3 to ensure healthy lives and promotion of well-being at all ages.

Within both the larger scope of the PEHSU work and these specific post-disaster recovery and resilience building efforts, the nursing profession plays a key role. Nurses are the largest group of health professionals in the US and they comprise the primary providers of hospital patient care, and delivery of long-term care (AACN 2019). This sector participates in all scopes of both clinical and community-centered education (Leffers 2018). Nurses play key roles in the national PEHSU network and lead other national environmental health efforts like Alliance of Nurses for Healthy Environments ([envirn.org](http://envirn.org)). The trust the public bestows in nurses and their interdisciplinary training contribute to the PEHSU programmatic efforts of community building, partnerships, outreach, and education (Milton, 2018; Sattlet, 2008). Nurses have longer consultations with patients and the frequency of attended return visits is slightly higher for nurses, compared to doctors. The longer consultations provide more health advice to patients, which can result in higher levels of patient satisfaction. In addition, they provide leadership and response to the reduction of pollution and most importantly management in all phases of disaster response during extreme weather events (Leffers, 2018). By providing children's environmental health (CEH) training and educational tools to nurses and other health care providers for early detection and prevention of environmental health exposures, the PEHSU aims to reduce CEH risks. The objective of this article is to describe the work of the Federal Region 2 PEHSU in PR and USVI supporting health professionals' knowledge building and how the nursing sector was integral to these efforts to build PEH capacity and promote access to PEH services for families to bolster disaster resilience.

## Pediatric Environmental Health in Puerto Rico and the U.S. Virgin Islands

Multiple structural reasons relating to funding, surveillance, and other long-standing policy towards U.S. territories underlie health disparities of people living in PR and USVI compared to the mainland U.S. (Rodríguez-Vilá et al 2017). Children experiencing diseases with known or suspected environmental contributors are also disproportionately burdened in these areas. Rates of childhood asthma are some of the highest in the country (Chen 2013; Bartolomei-Díaz 2008). Among infant mortality rates, PR and the USVI have a total of 6.3 and 7.7 deaths per 1000 live births respectively, while the rate in the mainland U.S. is lower at 5.7 per 1000 live births. (CIA 2018). In this Caribbean region, there are higher rates of adverse health conditions such as obesity, neurodevelopmental disorders, and prematurity; and evidence around differential environmental exposures continues to emerge (Watkins et al 2019).

A history of experimentation and exploitative treatment by the U.S. federal government and others in positions of power further exacerbates the distrust of healthcare as well as the perception of a contaminated environment and ill health (Rodríguez-Vilá et al 2017). Poor environmental enforcement and tax incentives for polluting industries have contributed to the now 18 Superfund sites in Puerto Rico and one in USVI plus hundreds of hazardous waste sites (EPA 2018). A 2012 survey of professionals working in pediatric health in PR reported multiple environmental exposure issues of concern: water contamination (25% respondents reported as a concern), pesticides (18%), air pollution (18%), and land waste (12.5%) (Ritter and Agu 2014).

Further complicating the situation, mass exodus of primary care physicians in Puerto Rico, due to an economic crisis, has led to a debilitated health infrastructure (Pinto 2019; Perreira 2017). Primary care physicians in Puerto Rico are aging and leaving the island faster than they are being replaced (Wilkinson 2019). USVI faces similar trials as Puerto Rico in the recruitment and retention of primary health providers that was exacerbated after the 2017 Hurricane season (Artiga 2018). These shifts have further placed nurses at the forefront of primary health care delivery. Additionally, this context highlights the critical nature of partnerships with key providers that participate in different health sectors (e.g. health care institutions, non-profits, departments of health). Health care professionals overall, and public health nurses specifically, play key roles in disaster resilience through their collaboration with other experts in the field such as environmentalists, epidemiologists, other health professionals (Jakeway 2008).

## History of PEHSU work in Puerto Rico and the U.S. Virgin Islands

For over a decade, the Federal Region 2 PEHSU has been proactively reaching out to populations at high risk of toxic environmental exposures, with a particular emphasis on increasing activities in PR and USVI (Agu 2013). We have, for example, co-organized two Children's Environmental Health conferences in Puerto Rico; supported an EPA-funded local PEHSU and fellowship training program based at University of Puerto Rico Medical Sciences Campus; consulted with USVI Department of Health and federal partners on specific cases (e.g. elevated blood lead levels and banned fungicide poisonings (Kulkarni

et al 2015)); collaborated with a USVI school nurse to identify and elevate school EH concerns; spearheaded a school integrated pest management project partnering with students, teachers, and school and government decision makers; and served as faculty for a distance learning collaborative via an telementoring platform called Project ECHO. In addition, grant funding from The Pew Charitable Trusts/RWJF in 2012 enabled a collaboration with local organizations Proyecto ENLACE and G-8 to conduct a health impact assessment in the Caño Martín Peña communities of San Juan (Sheffield et al 2014).

## PEHSU initiatives post-2017 hurricanes

Following the environmental disaster caused by the 2017 hurricanes in PR and USVI, Federal Region 2 PEHSU – with supplemental funding from the U.S. Centers for Disease Control and Prevention (CDC) - implemented an educational campaign to support health care and childcare providers in these areas to reduce post-hurricane environmental health (EH) risks and improve EH services and access to resources. The climate-related events have caused the emergence of hazards such as flooding with subsequent mold and vector problems, debris accumulation, indoor and outdoor air pollution from on-going generator use during the prolonged electrical grid failure, and significant disruptions in routines with school and childcare facility closures (Shultz 2018). In addition, as noted above, an exodus and subsequent shortage of primary health care providers occurred after the 2017 hurricanes (Artiga 2018). These exposures and health infrastructure problems have direct and indirect adverse effects on children’s well-being but the impact can be reduced with strong community disaster resilience (Baez 2007).

Our program used the following four phase framework: *planning, implementation, execution, and evaluation*. Figure 1 shows the components of each phase to bring about the overall effort to build PEH training and services. The phases are cyclical and iterative.

## Planning

The planning phase entailed determination of the factors that would define the initiative. We selected a “train the trainer” methodology based on feedback we had received from in-person meetings with health professionals in USVI and PR in December 2017 following the hurricanes that indicated preference for in-person interaction. The “train the trainer” methodology uses a modified version of a public health detailing approach developed by the New York City Department of Health. We used this approach to focus on environmental health keeping the same structure of detailing visits (i.e. brief, 10-minute encounters in clinical settings) and the use of “action kits” with specially developed materials around the key activities of screen, counsel, and refer. The results of the Public Health Detailing Program of the NYC Department of health suggested that detailing assisted in providing promotion of important clinical practices (e.g. up to a 42% increase in screening for clinical preventive services among providers at clinics that received detailing) and the improvement of population health. (Dresser et al 2012). In this manuscript, we use “trainer” and “detailer” somewhat interchangeably though, notably, trainers also did larger and more involved educational activities outside of the environmental health detailing.

Through the use of local environmental health liaisons and the creation of partnerships, we determined health provider groups that would become important assets in the implementation of this training campaign. We used sector mapping to identify key stakeholder groups in children's environmental health. Sector mapping considers the multiple settings and organizations that serve or otherwise cluster groups within a sector. The nursing sector was essential given their involvement across clinical, childcare programs, and other public health services where PEH education is crucial. Figure 2 shows a summary of a sector map showing the nursing sector with regards to children in Puerto Rico and the U.S. Virgin Islands. This graphic illustrates the linkages used by the PEHSU to strengthen networks that are essential to achieving environmental health delivery services to children.

As seen in Figure 2, we identified clinics, health professional associations, training locations, and community based organizations as important areas for nursing influence. Clinical entities include organizations running community health centers such as Frederiksted Health Care, Inc. in St. Croix, USVI; St. Thomas East End Medical Center Corporation, in St. Thomas, USVI; and HealthProMed in PR. In the clinical sector, we also include school and childcare programs such as Head Start and Early Head Start – a key partner spanning both PR and USVI and serving lower income populations. Also, within the clinical sector, the government agencies of these Caribbean SIDS and their respective Departments of Health have their own line of public health and clinical programs that were vital for this planning phase, for the identification of and access to key hospitals and clinics.

The professional associations encompass organizations such as Colegio de Profesionales de Enfermería in PR. Training locations include the Schools of Nursing at University of the Virgin Islands and Universidad Adventista de las Antillas in Mayaguez, PR. Community based organizations include, but are not limited to, Centro Mujeres Ayudando Madres (MAM) (a pregnancy and childbirth service organization) and Asociación de Salud Primaria de Puerto Rico (PR Primary Care Association). Organizations such as Centro MAM, that served an important recovery function in terms of prenatal care post-hurricanes, highlight the critical interplay of all these entities across the sectors. The community sector also involves public health community outreach through organizations where nurses engage with the community, such as Project Launch that convenes Wellness Committees in various municipalities in PR (e.g., Culebra and Fajardo). The sector mapping process clarified which stakeholders we were already engaging, and helped identify gaps in our outreach to nursing groups and other health professionals (Figure 2).

## Implementation

The implementation phase included onsite networking in PR and USVI to introduce the program and strengthen relationships. Using the sector mapping for nursing, we sought feedback from those working in settings such as teaching hospitals, departments of health and pediatric clinics on our planned methodology and presentations about the program. We then developed educational material including clinical tools, family resources, curriculum, and trainings on environmental health exposures particular to their region and post-disasters. Drawing from the public health detailing approach, we developed action kits to be given to the providers that include patient-friendly materials for distribution and use in the waiting

rooms and resources for the clinicians to build their PEH knowledge base and ease adoption of related services (e.g. billing codes). One example is an initiative called Prescriptions for Prevention for which locally relevant topics are complemented with actionable steps, with materials formatted so that clinicians can give them directly to patients (Figure 3).

## Execution

The PEH trainers visited clinics to provide on-site educational material and train nurses, other clinicians and trainees about PEH risks particular to their region. In addition to providing tools to health care providers, a survey assessed their experience, knowledge and perception of PEH issues most pertinent to their patients (results below in Outreach and Outcomes section). An “all office” approach, including all staff and clinicians, was used for detailing at clinics because by educating health professionals, such as nurses, who provide a first encounter with the patient, early onset detection can increase and environmental risks can be minimized.

During the execution phase, we disseminated information through the PEH trainers to nurses, other clinicians, community workers, and educational institutions for health providers and governmental agencies. With the help of the nursing sector map, we partnered with nurses of different sectors. For example, on one detailing visit in St. Thomas, USVI, our detailer connected with a nurse practitioner who later invited our team back to do a larger in-service training for all clinical staff at the practice as seen in Figure 4. In another example, when visiting pediatric health clinics in the municipality of Guayama, Puerto Rico detailers interacted with and provided action kits to nurses, physicians and staff. And community organizations led by nurses midwives were also impacted, such as at Centro MAM where the PEH trainer (Figure 4) educated community health workers and other health professionals. In another example, a partnership with the USVI Department of Health facilitated access to health professionals in the public and private sectors where our trainers used the environmental health detailing approach (as described above) to educate about environmental health issues. We have further illustrated the role PEHSU plays in bolstering children’s environmental health and interacting with these important partners and providers in Figure 5 and nursing plays a critical role throughout this work. In summary, many of these encounters between our detailers/trainers in pediatric clinical practices and public health leaders were with nursing professionals who were leaders in the delivery of primary care to the patients.

## Outreach and Outcomes

During the implementation phase, surveys were provided to program advisers, health providers and community stakeholders asking for feedback and interest regarding participation in future PEH activities. These surveys informed the subsequent sector mapping and educational tool development. Using an action kit, trainers “detailed” (i.e. conducted site visits) to 55 pediatric clinics and other health service sites reaching 761 health care and childcare personnel over a wide geographic area (Figure 6). Overall, 91 action kits were distributed to pediatric health providers.

After each detailing visit, a different survey was used to assess whether the educational material improved knowledge on the topic(s), health care provider perception on integrating PEH into their practice, and their clinical care needs related to environmental health exposures. These surveys were provided to key health professionals contacts at the sites that received action kits. We had a 79% response rate, with 29 respondents. When asked about how often the participants took an environmental health history 58% responded sometimes or often; 40% responded they rarely or were unsure. 73% responded that they agreed or strongly agreed when asked if they knew more about the topic CEH after reading the action kit and agreed or strongly agreed that they plan on making changes to their practice to improve the health of their patients based on the action kit.

Lastly, and a key outcome metric of the project, multiple new partners were engaged because of this project. One example of meaningful engagement involved a new partnership between PEHSU, Frederiksted Health Care, Inc (FHC, a federally qualified health center in St Croix, USVI), and Virgin Islands Good Food Coalition (an organization working to strengthen local food networks and health food access). As a result of this new collaboration, we organized a subsequent community event where approximately 200 families were provided local healthy food and PEHSU educational resources. Clinicians from FHC engaged by prescribing “healthy food”. Ultimately, we are making progress toward the UN SDGs and disaster resilience by building partnerships and reaching a bigger scope of sectors involved in pediatric environmental health.

### **Looking Forward: Future PEHSU initiatives in PR and USVI**

These experiences have shown that the PEHSU is able to leverage additional funding to deepen partnerships as with the health impact assessment work in the Caño Martín Peña communities and the hurricane recovery supplemental funding for island-wide initiatives described in this article. A historic pattern is that work with populations where health disparities exist is often deficit-focused (Richard et al 2011). In addition to adopting a more proactive approach to focus on these populations, our strategy has also shifted to be asset-focused, emphasizing support of local initiatives to improve sustainability of our program and invest in local solutions. For example, in the environment and sustainable energy sector, we lift up work being done by Island Green Living Association in USVI and Comité Dialogo Ambiental, Inc. in the Salinas and Guayama communities of PR. In the local food movements, there are numerous agricultural producers and markets such as the VI Good Food Coalition and ArtFarm on St. Croix, USVI and Cooperativa Orgánica Madre Tierra in San Juan, PR who are transforming the food landscape of these Caribbean SIDS and making major contributions to public health and disaster resilience. We are looking toward additional innovative approaches to link childcare and health care providers with these efforts through such initiatives as fruit and vegetable food coupons (similar to New York City’s Health Bucks program) as these linkages are critical for post-disaster resilience.

### **Conclusions**

In a time of growing environmental challenges, the necessity to build partnerships and strengthen relationships is vital. The sustained history of the PEHSU network is

critical to carrying out our current projects; and there remains a need to continue to explore mechanisms for improving this approach, building on successes and learning from challenges. Specifically, the emphasis needs to be on continuing to develop local PEH leadership, as external expertise is always limited and potentially counterproductive to the larger goal of building local capacity and sustainability for children's environmental health and disaster resilience. Through our on-site networking and sector mapping, we identified that the nursing health sector is far-reaching with potential to lead to subsequent activities and new partnerships. The importance of their role is heightened due to the health care sector and professional shortages faced in these Caribbean islands. For these reasons nurses are an important sector to impact in the implementation and action of any health education program to build local capacity and sustainability in SIDS. By providing nurses with training, educational material and consultation about PEH challenges faced they will be equipped for early detection, and management of cases. By creating alliances with the public and private sectors of health care in both PR and USVI, we are providing support to already existing programs and establishing trust between our group, local health providers, and the larger community. These efforts are all in keeping with UN SDGs, specifically goals 3, 13, 17 on health promotion, sustainability and partnerships. The PEHSU activities all aim to increase the availability of preventive measures, to support and encourage a sense of community involvement and self-transformation when responding to environmental stressors, and to enable restoration of routines for children as quickly as possible when necessary, ultimately improving baseline health and contributing to disaster resilience.

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### References

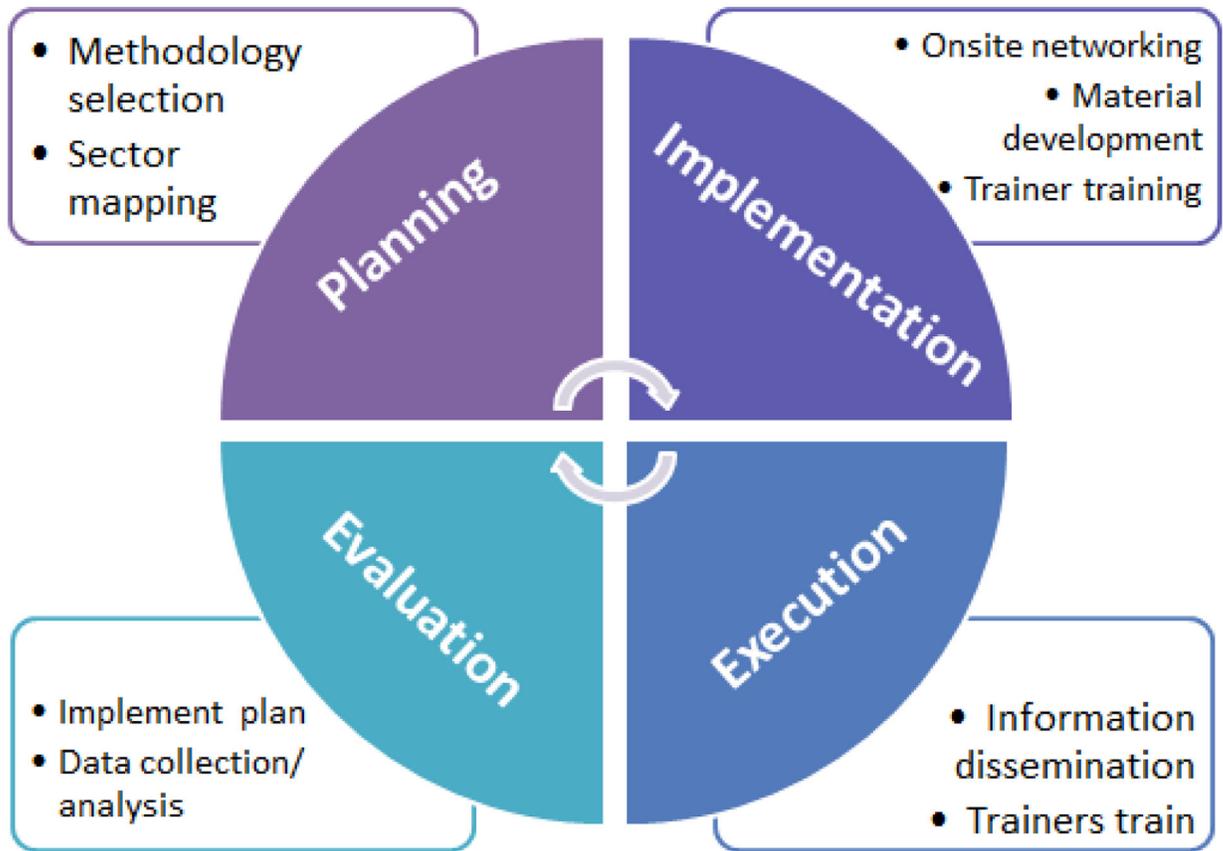
- American Association of Colleges of Nursing, AACN (2019, April 1). Nursing Fact Sheet. Retrieved April 26, 2021 from [https://www.aacnnursing.org/News-Information/Fact-Sheets/Nursing-Fact-Sheet#:~:text=Fact%20Sheets-,Nursing%20Fact%20Sheet,registered%20nurses%20\(RNs\)%20nationwide](https://www.aacnnursing.org/News-Information/Fact-Sheets/Nursing-Fact-Sheet#:~:text=Fact%20Sheets-,Nursing%20Fact%20Sheet,registered%20nurses%20(RNs)%20nationwide)
- Aburn G, Gott M, Hoare K. (2016). What is resilience? An Integrative Review of the empirical literature. *J Adv Nurs*;72(5):980–1000. doi: 10.1111/jan.12888. Epub 2016 Jan 7. [PubMed: 26748456]
- Agu D (2013). Utilizing GIS and mapping for more equitable distributions of environmental health services to Spanish-speaking populations. Abstract presentation at 141st APHA Annual Meeting and Exposition. Boston, MA.
- Artiga S, Hall C, Rudowitz R, Lyons B. (2018, April 24). Health care in Puerto Rico and the U.S. VIRGIN Islands: A Six-month CHECK-UP after the Storms (Report) Retrieved April 26, 2021, from <https://www.kff.org/medicaid/issue-brief/health-care-in-puerto-rico-and-the-u-s-virgin-islands-a-six-month-check-up-after-the-storms-report/>

- Baez JE, Santos IV, Abadie A, Afridi F, Black D, Engelhardt GV, Field E, Jensen RD, Kubik JD, Liebman JC, Zeckhauser RJ. (2007). Children's Vulnerability to Weather Shocks: A Natural Disaster as a Natural Experiment. Available at: [https://pdfs.semanticscholar.org/6356/66ea2c238a86928bb0e77cc3b0be746bfdae.pdf?\\_ga=2.8656950.2031328815.1555611427-2067435386.1555611427](https://pdfs.semanticscholar.org/6356/66ea2c238a86928bb0e77cc3b0be746bfdae.pdf?_ga=2.8656950.2031328815.1555611427-2067435386.1555611427) Accessed 18 Apr 2019.
- Bartolomei-Diaz J (2008). Epidemiological profile of Asthma in Puerto Rico. Technical Report. San Juan, PR: Puerto Rico Department of Health;. Available at: [https://estadisticas.pr/files/BibliotecaVirtual/estadisticas/biblioteca/DS/DS\\_Informe\\_Vigilancia\\_Asma.pdf](https://estadisticas.pr/files/BibliotecaVirtual/estadisticas/biblioteca/DS/DS_Informe_Vigilancia_Asma.pdf) Accessed 13 Apr 2019.
- CDC (Centers for Disease Control and Prevention). (1999). Framework for program evaluation in public health. *MMWR*;48(No. RR-11): 1–40.
- CDC (Centers for Disease Control and Prevention). (2019). Planning, Implementing, and Evaluating an Intervention—An Overview. Retrieved from <https://www.cdc.gov/violenceprevention/pdf/chapter1-a.pdf> Accessed 15 Apr 2019.
- CIA (Central Intelligence Agency). (2018). Field Listing: Infant mortality rate — The World Factbook - Central Intelligence Agency. Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/fields/354.html#VQ>
- Chen W, Boutaoui N, Brehm J, Han Y, Schmitz C, Cressley A. et al. (2013). ADCYAP1R1 and Asthma in Puerto Rican Children. *American Journal Of Respiratory And Critical Care Medicine*, 187(6), 584–588. doi: 10.1164/rccm.201210-1789oc [PubMed: 23328528]
- Combaz E (2014). Disaster resilience: Topic guide. Birmingham, UK: GSDRC, University of Birmingham. Available at: [https://gsdrc.org/wp-content/uploads/2014/02/GSDRC\\_DR\\_topic\\_guide.pdf](https://gsdrc.org/wp-content/uploads/2014/02/GSDRC_DR_topic_guide.pdf) Accessed 11 Apr 2019.
- EPA (US Environmental Protection Agency). National priorities list (NPL) sites - by state 2018. Available at: <https://www.epa.gov/superfund/national-priorities-list-npl-sites-state#PR> Accessed 13 Apr 2019.
- Dresser MG, Short L, Wedemeyer L, Bredow VL, Sacks R, Larson K, Levy J, Silver LD. (2012). Public health detailing of primary care providers: New York City's experience, 2003–2010. *Am J Prev Med*. Jun;42(6 Suppl 2):S122–34. doi: 10.1016/j.amepre.2012.03.014. [PubMed: 22704430]
- Garg A, Sandel M, Dworkin PH, Kahn RS, Zuckerman B. (2012). From medical home to health neighborhood: transforming the medical home into a community-based health neighborhood. *J Pediatr*. 160(4):535–536.e1. doi: 10.1016/j.jpeds.2012.01.001. [PubMed: 22424405]
- Jakeway CC, LaRosa G, Cary A, Schoenfisch S. (2015). Association of State and Territorial Directors of Nursing. The role of public health nurses in emergency preparedness and response: a position paper of the Association of State and Territorial Directors of Nursing. *Public Health Nurs*;25(4):353–61. doi: 10.1111/j.1525-1446.2008.00716.x.
- Kaiser Family Foundation. (2017). U.S. Virgin Islands: Fast Facts Retrieved from <https://www.kff.org/disparities-policy/fact-sheet/u-s-virgin-islands-fast-facts/> Accessed 13 Apr 2019.
- Kulkarni PA, Duncan MA, Watters MT, Graziano LT, Vaouli E, Cseh LF, Risher JF, Orr MF, Hunte-Cesar TC, Ellis EM. (2015). Severe Illness from Methyl Bromide Exposure at a Condominium Resort—U.S. Virgin Islands, March 2015. *MMWR Morb Mortal Wkly Rep* Jul 24;64(28):763–6. [PubMed: 26203630]
- Landrigan P, Etzel R. (2014,). Children's Environmental Health – A New Branch of Pediatrics, in *Textbook of Children's Environmental Health*, Landrigan P and Etzel R, Editors. Oxford University Press: New York, NY. p. 3.
- Laurant M, van der Biezen M, Wijers N, Watananirun K, Kontopantelis E, van Vught AJ. (2018). Nurses as substitutes for doctors in primary care. *The Cochrane database of systematic reviews*, 7(7), CD001271. 10.1002/14651858.CD001271.pub3 [PubMed: 30011347]
- Leffers J, Butterfield P. (2018). Nurses play essential roles in reducing health problems due to climate change. *Nursing Outlook*, 66(2), 210–213. doi:10.1016/j.outlook.2018.02.008 [PubMed: 29599047]
- Leith Sly J, Carpenter DO. (2012). Special vulnerability of children to environmental exposures. *Rev Environ Health*;27(4):151–7. Review. [PubMed: 23095179]

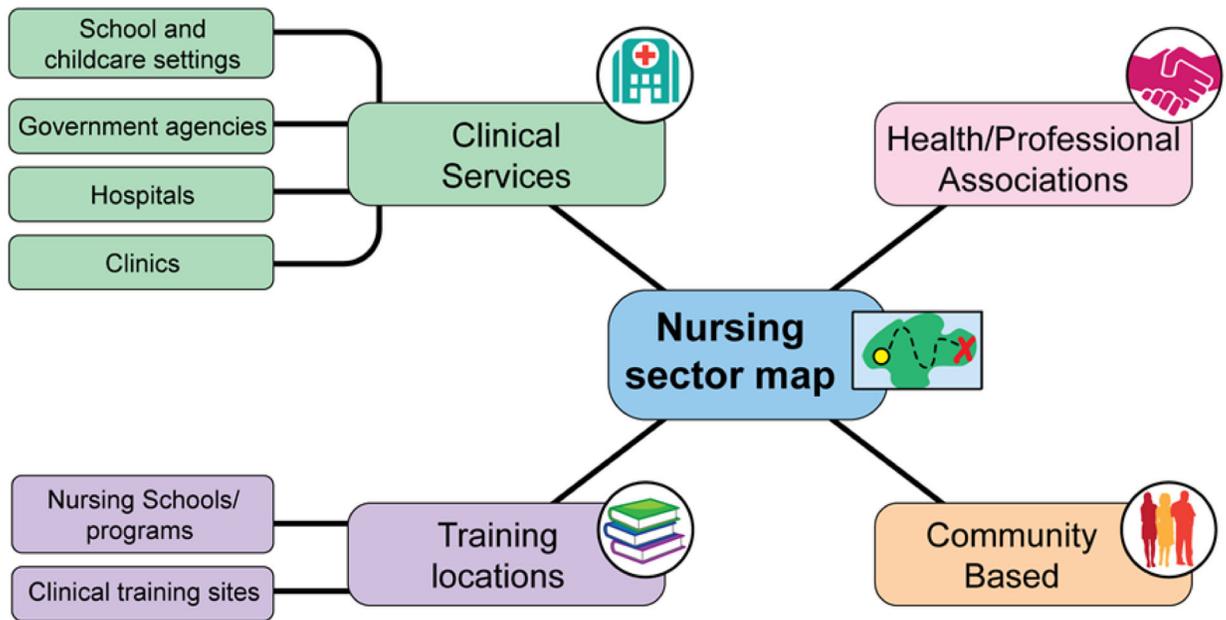
- McCurdy L, Roberts J, Rogers B, Love R, Etzel R, Paulson J. et al. (2004). Incorporating Environmental Health into Pediatric Medical and Nursing Education. *Environmental Health Perspectives*, 112(17), 1755–1760. doi: 10.1289/ehp.7166 [PubMed: 15579423]
- Milton CL. (2018). Will Nursing Continue as the Most Trusted Profession? An Ethical Overview. *Nursing Science Quarterly*;31(1):15–16. doi:10.1177/0894318417741099 [PubMed: 29235949]
- Morton S, Pencheon D, Squires N. (2017). Sustainable Development Goals (SDGs), and their implementation: A national global framework for health, development and equity needs a systems approach at every level. *Br Med Bull*. Dec 1;124(1):81–90. doi: 10.1093/bmb/ldx031. Review. [PubMed: 29069332]
- Paulson JA, Karr CJ, Seltzer JM, et al. (2009). Development of the pediatric environmental health specialty unit network in North America. *Am J Public Health*;99 (Suppl 3):S511–S516. doi:10.2105/AJPH.2008.154641 [PubMed: 19890150]
- Perreira K, Peters R, Lallemand N, Zuckerman S. (2017). Puerto Rico Health Care Infrastructure Assessment: Site Visit Report. Retrieved from [https://www.urban.org/sites/default/files/publication/87011/2001050-puerto-rico-health-care-infrastructure-assessment-site-visit-report\\_1.pdf](https://www.urban.org/sites/default/files/publication/87011/2001050-puerto-rico-health-care-infrastructure-assessment-site-visit-report_1.pdf) Accessed 18 Apr 2019.
- Pinto DM. (2019). Preocupación por Éxodo DE médicos Primarios Puertorriqueños A Estados Unidos. Retrieved April 26, 2021, from <https://medicinaysaludpublica.com/noticias/general/preocupacion-porexodo-de-medicos-primarios-puertorriquenos-a-estados-unidos/5442>
- Richard L, Gauvin L, Raine K. (2011). Ecological models revisited: their uses and evolution in health promotion over two decades. *Annu Rev Public Health*. 32:307–26. doi: 10.1146/annurev-publhealth-031210-101141. Review. [PubMed: 21219155]
- Ritter L, Agu D. (2014). Improving environmental exposure and health outreach to children in Puerto Rico: A geographic information systems approach. Abstract presentation at 142nd APHA Annual Meeting and Exposition. New Orleans, LA.
- Rodríguez-Vilá O, Nuti SV, Krumholz HM. (2017). Healthcare Disparities Affecting Americans in the US Territories: A Century-Old Dilemma. *AmJ Med*. Feb;130(2):e39–e42. doi: 10.1016/j.amjmed.2016.07.036. [PubMed: 27593609]
- Sattler B, Davis del BA. (2008). Nurses' role in children's environmental health protection. *Pediatr Nurs*. Jul-Aug;34(4):329–39. [PubMed: 18814568]
- Sheffield PE, Landrigan PJ. (2011). Global climate change and children's health: threats and strategies for prevention. *Environ Health Perspect*. Mar;119(3):291–8. doi: 10.1289/ehp.1002233. [PubMed: 20947468]
- Sheffield P, Rowe M, Agu D, Rodríguez L, Avilés K. (2014). Health impact assessments for environmental restoration: the case of Caño Martín Peña. *Ann Glob Health*. 80(4):296–302. doi: 10.1016/j.aogh.2014.07.001. [PubMed: 25459331]
- Shultz J, Kossin J, Shepherd J, Ransdell J, Walshe R, Kelman I, Galea S. (2018). Risks, Health Consequences, and Response Challenges for Small-Island-Based Populations: Observations from the 2017 Atlantic Hurricane Season. *Disaster Medicine and Public Health Preparedness*, 13(01), 5–17. doi: 10.1017/dmp.2018.28 [PubMed: 29622053]
- Watkins DJ, Vélez-Vega CM, Rosario Z, Cordero JF, Alshawabkeh AN, Meeker JD. (2019). Preliminary assessment of exposure to persistent organic pollutants among pregnant women in Puerto Rico. *Int J Hyg Environ Health*. Mar;222(2):327–331. doi: 10.1016/j.ijheh.2019.02.001. [PubMed: 30738742]
- Wilkinson E, Killeen D, Pérez-López GJ, Jabbarpour Y. (2019, December 13). A shrinking primary Care workforce in Puerto Rico. Retrieved April 26, 2021, from <https://www.graham-center.org/rgc/publications-reports/publications/one-pagers/shrinking-pc-workforce-puerto-rico.html>

**Core Findings of the manuscript:**

- The Federal Region 2 Pediatric Environmental Health Specialty Unit's (PEHSU) work in Puerto Rico and the U.S. Virgin Islands have strengthened local health communities in pediatrics' environmental health and created partnerships to build sustainability and resilience post-disasters.
- Projects done by PEHSU in these territories have identified key health sectors in the nursing health care system that have embraced a preventive health care approach to pediatrics at a grassroots level.
- These collaborations with local health sectors have improved the promotion and strength of local capacities in children's environmental health
- Utilizing an evidence based strategy towards health professional education has increased knowledge on PEH per surveys provided to trainers and trainees.



**Figure 1.**  
Pediatric Environmental Health training and services development framework



**Figure 2.** Nursing sector map related to children in Puerto Rico and the U.S. Virgin Islands

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## ¿Usted sabía que?

### Moho

*El moho puede desencadenar asma y alergias. El moho necesita humedad y alimento para crecer. Tome pasos necesarios para prevenir moho y mantener un hogar saludable.*

#### Plan de Acción

- Reduzca la humedad y aumente la ventilación, usando un ventilador, para el intercambio del aire. Abra las ventanas mientras se baña.
- Arregle goteras de agua: Mantenga comunicación con su propietario si reside en un alquiler.
- Si usted ve moho:
  - Primero, elimine la fuente de humedad/agua.

**Figure 3.**

Sample excerpt from a Prescription for Prevention on reducing exposure to mold (“moho” in Spanish). English version of this resource and others are available at the Region 2 PEHSU website: <https://icahn.mssm.edu/research/pehsu/us-virgin-islands-puerto-rico>



**Figure 4.** PEH trainers educating community health professionals in a community garden at Centro MAM in San Juan, PR on health benefits of fruits and vegetables and reduced pesticide exposures (top) and doing an in-service training at St. Thomas East End Medical Center Corporation, in St. Thomas, USVI. (Photo credit: P. Sheffield, permissions granted by photographer and identifiable subjects)



**FIGURE 5.**

The graphic displays the PEHSU's work through the health provider detailing campaign to better enable providers to screen, counsel, and refer families with environmental health concerns. (#1) A family can be exposed to environmental health exposures pertaining to their region. (#2) Families come into contact with health care providers, such as nurses and physicians, who are the first line responders dealing with CEH risks. (#3) The training from the PR and USVI PEHSU detailing campaign provided tools and education to health providers to maximize prevention and early exposure detection, response and awareness. The PEHSU also serves as the entity where providers can turn for additional expertise as needed. (#4) Building partnerships with local organizations (Government agencies and community organizations) and linking providers and patients to local resources bolsters disaster response.



**Figure 6.**

Map presenting the 55 sites where over 700 providers were educated on PEH that were impacted through the PEHSU detailing campaign post-2017 hurricanes in the Caribbean. The numbers in the graphic represent the number of sites visited in each area of PR and the USVI.