



Published in final edited form as:

Int Q Community Health Educ. 2016 July ; 36(4): 231–240. doi:10.1177/0272684X16657734.

Improving Latino youths' environmental health literacy and leadership skills through participatory research on chemical exposures in cosmetics: The HERMOSA study

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Abstract

To increase environmental health literacy (EHL) and leadership skills in Latino youth in Salinas, CA., we worked from 2012–2015 with 15 members of the CHAMACOS Youth Community Council (YCC), an outreach arm of a longitudinal study of impacts of environmental chemicals on children's health. The YCC program provided hands-on research experiences related to Endocrine Disrupting Chemicals (EDCs) in cosmetics and their possible health effects.

We use participatory research principles and Bloom's Taxonomy of Educational Objectives to describe the development of EHC and leadership in the youth co-researchers. Using data from multiple qualitative sources, we explore the youths' engagement in a wide range of research and action processes. Promising outcomes, including perceptions of improved youth self-esteem, EHL, leadership, and career orientation are discussed, as are challenges, such as time constraints and high priority youth concerns not addressed by the study. Implications for other youth-engaged participatory science and leadership programs are presented.

Keywords

Adolescent; environmental health; cosmetics; community based participatory research

INTRODUCTION

Community-based participatory research (CBPR) uses community engagement, bidirectional learning, and a commitment to “balancing research and action” to develop more effective and culturally relevant interventions.^{1,2} Additionally, CBPR builds local

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Competing financial interests: The authors declare they have no actual or potential competing financial interests.

capacity in research, advocacy, and leadership skills to foster sustainable, long-term change.^{3,4} CBPR with youth can be particularly effective in building self-esteem and future orientation among youth, while also nurturing future community leaders.^{5,6} We conducted a CBPR study on chemicals in cosmetics in collaboration with a team of youth toward the goals of lowering adolescent girls' exposure to endocrine disrupting chemicals (EDCs) while increasing environmental health literacy and skills in leadership and participatory research in the youth partners.

Over 10,000 chemical ingredients are registered for use in cosmetics and personal care products, but few have been tested for long-term toxicity.⁷ Few federal regulations limit the ingredients used in cosmetics, which include several suspected EDCs, which may block, mimic, or interfere with the function of hormones in the body and have been linked to poor health outcomes.⁸ Exposure to certain EDCs used in cosmetics and personal care products is higher in women and girls,⁹ as they tend to use more of these products than boys and men.¹⁰ The widespread presence of personal care products on store shelves, limited awareness about the lack of cosmetic regulation, and uncertain data about the long-term health impacts of endocrine disruption may contribute to a public perception of their safety.

To address public health concerns about exposures to EDCs in cosmetics, we invited 15 high school students to collaborate in an innovative, CBPR project based in the urban agricultural city of Salinas, CA. The Health and Environmental Research on Make-up of Salinas Adolescents (HERMOSA) study had three goals: (a) to learn the extent to which young Latina women are exposed to EDCs through their personal care products and determine whether switching to alternate products lowered their exposure; (b) to increase awareness about EDCs in personal care products to foster change; and (c) to increase environmental health literacy and scientific research, critical thinking, advocacy, and leadership skills in our youth partners. To achieve the first goal, we enrolled 100 Latinas aged 14 to 18 in the study, collected urine samples to measure levels of four suspected EDCs found in cosmetics, provided the girls with low-chemical alternative personal care products to use, and then collected follow-up urine samples. The results demonstrated that personal care products are a significant source of exposure and that their EDC concentrations decreased when they stopped using their regular products.¹¹ To address the second goal, we worked with our youth partners to develop educational messages, publicize the study findings, and develop advocacy activities. The third goal, which is the subject of this article, was achieved through the active participation and engagement of the youth in all phases of the 3-year project. The youth were integrally involved in the planning, design, and implementation of the study in Year 1; the analysis and dissemination of results to study participants in Year 2; and the development and implementation of educational materials and advocacy activities in Year 3 based on the study's findings. We focus here on the impact of the engagement of the 15 youth members of the study team, on both their gains in knowledge and understanding of environmental health literacy and on the development of their leadership abilities and research skills. The results reported here are based on our collective, collaborative analysis of student reflections provided in written responses, group discussions, interviews, and adult staff member participant observations.

CBPR has been previously used in studying and addressing environmental health concerns, ranging from childhood asthma and air pollution^{12–14} to exposure to violence on marginalized communities of color.¹⁵ In addition to improving the evidence base in such areas, participatory research has often provided an opportunity for people to learn about—and act on—environmental hazards.^{16,17} In the process, it has increasingly been seen as a useful tool for improving environmental health literacy.¹⁸

Following the recommendation of Finn and O’Fallon,¹⁸ we used Bloom’s *Taxonomy for Educational Objectives* as a framework for assessing the youth researchers’ development of critical thinking skills, in general, and environmental health literacy, in particular. Table 1 shows the progression of higher order thinking skills codified in the Bloom taxonomy,¹⁹ from acquiring and comprehending knowledge, through application and analysis, to synthesis and evaluation, and their application and how these constructs were operationalized in this research in terms of environmental health literacy.

Consistent with core principles of CBPR,^{1,20–22} in addition to critical thinking skills and environmental health literacy, we also assessed the impact of participation in terms of leadership development, advocacy, increased self-esteem, and other common and valued CBPR outcomes.

BACKGROUND

The 15 youth collaborators on the HERMOSA Study were members of the Youth Community Council (YCC) of the Center for the Health Assessment of Mothers and Children of Salinas (CHAMACOS), a multifaceted research program investigating the impact of pesticides and other environmental chemicals on the health of farmworker families in the Salinas Valley, California.²³ The YCC began as a youth participatory action research project of CHAMACOS in 2010 to help local high school students learn about environmental health issues, participate in research processes, and take action to create healthier environments in their communities.²⁴ Members of the CHAMACOS YCC were recruited from local high schools and met biweekly to engage in environmental health issues and environmental health research. In addition to the professional and academic opportunities provided by the YCC, youth members were compensated for their time with \$20 gift cards to local stores for each meeting they attended.

The HERMOSA Study was the third summer research project undertaken by the CHAMACOS YCC. Previous YCC projects included a community health assessment using the Photovoice “visual voices” methodology^{25,26} and a survey of over 270 residents to assess walkability issues in Salinas. In both projects, YCC members collected the data, analyzed the results, discussed the issues impacting health, and summarized their findings in reports and presentations to local policymakers, community members, and other audiences.²⁴ Consistent with the community capacity building goals of CBPR, the youth learned about the scientific method; the process of conducting assessments, analyzing data, and presenting their findings; and selecting and working on actions to create a healthier environment in their community, as well as the history and importance of ethical human subjects research.²⁷

CBPR With Youth:

Although participatory research ideally begins with a topic identified by the community,²⁸ in the HERMOSA project, as in many participatory research efforts with youth, the topic was proposed by adult research partners, while enabling interested young people to increasingly take ownership and learn new skills. Numerous intervention efforts to engage middle and high school aged youth in CBPR have demonstrated that this approach provides rich data, aids in its dissemination and application, and helps youth researchers become empowered by developing new skills, expanding social networks, and developing a sense of purpose and future orientation.^{5,6,29,30}

Environmental Health Literacy:

Finn and O’Fallon¹⁸ propose the concept of environmental health literacy to describe the learning and agency involved in increasing one’s understanding of how hazards in people’s surroundings can affect their health.¹⁸ In developing environmental health literacy, the individual’s understanding, capacity, and agency increase to “ensure that the translation of research findings leads to greater understanding of specific risks, the reduction of exposures, and the improvement of health outcomes for individuals and communities.”¹⁸ With these goals in mind, we sought to improve the environmental health literacy of the youth researchers, strengthen their capacity to act, and support them in working to provide a healthier environment in their community, especially as it relates to EDCs in cosmetics.

METHODS:

We used several methods to assess the processes and outcomes of YCC members’ involvement as research partners in the HERMOSA project. Primary data collection included written personal reflections by the youth researchers at the end of many of the sessions over the 3 years of the project, written responses to open-ended questions on a questionnaire administered at the end of the project, televised interviews, and participant observation by the First author who recorded both his own observations and verbatim quotes from group discussions with the youth researchers. Additional participant observation data were provided by other adult project staff who observed and interacted with the youth at meetings, educational presentations, and other events.

Data were analyzed by the first author, in consultation with and corroborated by two additional adult research partners, to identify key and convergent themes across the different methods of collection. Key themes that emerged were the youths’ growth in the areas of environmental health literacy, leadership development, self-esteem, and academic skills and career orientation. Four youth researchers (coauthors on this article) provided member checking through their review of the findings, with any discrepancies discussed and reconciled through consensus discussions.

The University of California (UC) Berkeley’s Committee for the Protection of Human Subjects approved the youths’ participation in the assessment process and other research activities (protocol number # 2011–07-3412) and informed consent was obtained from all youth.

Project description:

In the HERMOSA project, youth researchers participated in a range of tasks that strengthened their environmental health literacy, critical thinking, research, and leadership skills. In Table 2, we describe the youth researchers' roles in each phase of the HERMOSA project and their intended relationship to the development of the critical thinking skills reflected in Bloom's taxonomy.

Youth researchers' roles in relation to Bloom Taxonomy Domains

Phase 1: Preparation. From December 2012 to May 2013, HERMOSA researchers and staff met with the YCC members bimonthly for interactive sessions to provide background knowledge and skills necessary to design and implement the project. Preparatory sessions focused on (a) improving environmental health literacy (including discussions about EDCs in cosmetics, cosmetics safety, and regulation, with a visit from an employee from the state's environmental health branch), (b) research and critical thinking skills (including exercises on collecting questionnaire data and training in ethical human subjects' research), and (c) advocacy and leadership (including time with an organizer with the Campaign for Safe Cosmetics to discuss safe cosmetics advocacy). Meetings also included exercises to help youth to develop a variety of leadership skills, including group facilitation, effective presentations, conflict resolution, and planning. Consistent with Bloom's taxonomy, the activities in this preparation phase focused on the most basic learning objectives, namely, "Recognition," as they learned about EDCs in cosmetics, and "Understanding," as they learned how EDCs in personal care products might impact their health and the environment (see Table 2).

Phase 2: Designing the intervention and building youth ownership. From March to May of 2013, the YCC members were encouraged to take ownership of the project in multiple ways. They worked with adult members of the team to name the study (Health and Environmental Research in Make-up of Salinas Adolescents, whose acronym means "beautiful" in Spanish) and create a project logo. The youth researchers also provided feedback on the wording of questionnaire items, tested low-chemical alternative personal care products, chose which ones would be used, and developed a subject recruitment strategy.

Phase 3: Conducting the intervention. In June and July of 2013, 12 of the YCC members were hired as UC Berkeley research assistants to conduct the study, while the remaining three members continued to be involved through YCC meetings and volunteering with the project. The first week was dedicated to team building and training, while the following 8 weeks were devoted to implementing the intervention study. The youth researchers were responsible for recruiting a convenience sample of 100 adolescent Latinas through their peer networks using word of mouth, phone calls, text messaging, and social media. Youth researchers informed their peers about the benefits and potential burdens of study participation and scheduled appointments. During two study visits, they greeted participants, conducted computer-assisted interviews about personal care product use in the past 48 hours, and obtained urine samples. The youth researchers also explained the intervention to the participants, educating them about EDCs in cosmetics, stressing that they should not use any of their own personal care products for 3 days, and helping them select low-chemical

replacement products (including shampoo, soap, deodorant, and make-up) from the HERMOSA “Beauty Bar” to use instead. All visit activities were managed by youth with supervision from HERMOSA research staff.

In a significant extension of standard educational programs and, in certain respects, CBPR methodology as well, engaging youth in designing the research, collecting data, and informing participants about the nature and purpose of the study, was designed to reinforce and strengthen the internalization of the “relevance, rigor, and reach” of the information about the EDCs.³²

Phase 4: From research to practice: Education and Advocacy. In this final phase, from August 2013 to June 2015, the youth researchers focused on using what they had learned as the basis for making positive change, a central tenet of CBPR.^{1,3,22} The youth researchers held a community forum for participants to hear about the study findings and privately learn their own chemical levels. Educational presentations about the study findings were also conducted by the youth researchers for local health department staff, their peers in school classes, and for the public at community events. Several youth researchers also presented the HERMOSA findings with adult research partners at scientific meetings.

Presentations about the findings of the study proved to be a compelling way to make key points about chemicals in cosmetics and provided a logical opportunity for the youth to provide educational messages about cosmetics safety. After learning about the study results, audience members were frequently interested in learning about the steps they could take to reduce their own EDC exposure. Youth researchers developed educational materials about the potential health effects of EDCs in cosmetics that were tailored to Latina youth, including shopping guides and recipe cards for homemade alternatives (see <http://cerch.org/research-programs/hermosastudy/hermosa-resources-for-safer-cosmetics/>). They also developed a social media presence on Instagram, Facebook, and YouTube using insights gained from their own experiences as members of these online communities. Traditional media also were used for dissemination of both research findings and educational messages, with several youth researchers interviewed for stories in newspapers and magazines, local English- and Spanish-language television news, and regional and national radio programs.

Finally, youth researchers identified and implemented advocacy strategies, sending letters to managers of local retailers requesting that they stock low-chemical personal care products and creating an online petition (which had gained 439 signatures by December 2015 [<https://www.change.org/p/do-away-with-harmful-personal-care-products>]) to pressure major retailers to provide more low-chemical alternatives. Youth researchers were invited to present the study and its findings to regulators at the California Safer Consumer Products Program. The youth also met with California legislators and policymakers in Sacramento to present the study findings and express their concern about EDCs in cosmetics widely used by adolescents.

RESULTS:

Over the course of the youth researchers' engagement in the HERMOSA study, we aimed to evaluate youth development in the key areas of environmental health literacy, research and critical thinking skills, leadership, self-esteem, and academic goals and career orientation. We were particularly interested in the potential synergistic interaction between designing a small environmental health research project and the development of critical thinking skills in the area of environmental health literacy.

Environmental Health Literacy:

Through the distinct project activities in the different phases of the research, the youth researchers learned basic information about how chemicals in their cosmetics enter their bodies through dermal absorption, inhalation, or ingestion. To bring home the relevance of this information, they actually observed how those chemicals can be measured in their urine. Through lectures, hands-on learning, quizzes, visiting the laboratories where the chemicals were analyzed, and developing their own communication messaging, all 15 youth researchers learned where EDCs were found and how to avoid them, how personal care product chemicals are regulated, and the major deficiencies in current regulation. Their increase in environmental health knowledge was evidenced by the fluency and professionalism with which they discussed these issues, in both English and Spanish, with audiences that ranged from farmworkers at local health fairs to state legislators and their staffers.

To demonstrate their ability to *apply* the new materials they had learned, the youth researchers then developed and presented HERMOSA study information to study participants, students, and community members. These presentations required practice and repetition, and thus solidified their understanding of the topic. As one wrote in a reflection:

“Working with the YCC for the past summer has really been a huge eye-opening experience. Never had I ever considered how my deodorant or body spray could possibly contain all these chemicals that could possibly impact my health. I just assumed that, since all these products are on the market, they are all strictly regulated for safety.”

Designing the research project also demonstrated the ability to apply their understanding of research methodology. They were required to think through the best way to develop the study protocol to collect data on teen cosmetic product use, and to think through different possibilities to identify one intervention that could be effective and realistic. They also learned to develop and state hypotheses about how cosmetic products are chosen by consumers, especially in considering the role of the media and other factors that might influence youth decision making. In expressing her growing environmental health literacy, one student wrote in a reflection: “I look at the world differently because of all the different chemicals around us.” Youth coauthors reported that their understanding of environmental health had grown to include *all* of their surroundings, where previously they had understood environmental health to be limited to things like air and water quality.

As a participant observer and coauthor on this study noted, by actively engaging interested members of the CHAMACOS YCC in a hands-on exercise—using their cell phones to discover what chemicals could be found in popular self-care products—the senior author was able to recruit over a dozen members who were highly enthusiastic about participating as coresearchers on the HERMOSA project. Furthermore, by embracing the concepts of youth ownership and empowerment from the beginning of the funded project period, she and the other adult team members and staff increasingly widened and deepened opportunities for high-level youth engagement. Including youth researchers in the study provided a promising way of introducing the issue of endocrine disruptors in personal care products as the youth had the opportunity to learn more about this issue, and environmental health more broadly.

Leadership development:

The HERMOSA study was designed to improve the youths' leadership capacity by developing their confidence and skills in public speaking, group facilitation, conflict resolution, participatory processes, action planning, and sharing their knowledge broadly in their community. Almost all of the youth researchers demonstrated increased confidence in their abilities to talk about environmental health issues with authority with their peers, family, and community. One student reported in a written reflection: "I gained presentation skills that I had never taken into consideration before and [that] were not taught to me in school." Another noted that involvement in the project "has definitely helped me in teamwork skills and being more professional overall."

Through developing the education and advocacy projects, youth reflected on and identified the changes that they wanted to see in their communities. As the youth spoke out in classrooms, at community forums, and in other settings about chemicals in cosmetics, the topic took on even greater importance to the youth researchers themselves. As one youth wrote in the final questionnaire, "[The project] has changed my mind set. I have become more involved in my community and outspoken. I have also become hungry for change."

They made presentations to community groups in both English and Spanish and became powerful presenters because they were able to frame the issues in language that their friends, family, and neighbors could understand. As one youth commented during a televised interview on the local Spanish language television news program (Univision Monterey-Salinas, <http://cerch.org/youth-members-of-the-hermosa-study-featured-on-salinas-and-monterey-tv-station-ksbw/>), "A great impact from my point of view has been to learn how to do a scientific study. I thought scientists were just in laboratories." Participant observations and responses on weekly reflections similarly demonstrated the youth researchers' growing appreciation of science and their own agency and ability to be part of the knowledge creation process. In written reflections, one youth noted the satisfaction that she derived from helping educate her community and benefit others. Another youth wrote, "I liked informing participants and community members about endocrine disruptors. It felt like I was making a positive change in my community ... conducting research was empowering." Emphasizing and reinforcing the idea that youth are capable of taking a leadership role in their community for positive change has been a key element of the HERMOSA project and the broader CHAMACOS YCC.

Self Esteem:

Youth reported a strong sense of pride when the HERMOSA Study was profiled on a local Spanish television news program because it allowed their parents to see them in this leadership role. While the youth expressed pride in their city because of the strong work ethic, they also reported feeling stigmatized by the frequent, negative messages about the high rates of gang violence, unintended teen pregnancy, and low rates of academic achievement in Salinas. Such negative messaging can lower self-expectations for success and diminish confidence in youths' ability to make a positive impact in the community and their world. Based on participant observations by the adult trainers and analyses of the youths' written reflections over the course of the project, participating in the HERMOSA study helped combat the impacts of negative messaging. Reflecting on the broader YCC project, one youth wrote: "The YCC has been a positive motivator in my life because I'm around other people who think positively." The positive encouragement from adult mentors, together with strong social bonds, helped create a shared commitment to completing the work of the study. Another student said that presenting the HERMOSA study at scientific meetings or to lawmakers made her proud to be an example of youth achievement to counter the usual negative stereotypes of Salinas's youth. Another written reflection noted: "Working with others who have high expectations for me has challenged me to try my best at what I do and forced me to have higher expectations for myself."

By the end of the data collection phase, when the youth had recruited and guided 100 girls through the study protocol, they were able to see their accomplishment and feel a sense of pride from the work they had completed. As one youth reflected, "One of the most memorable moments was at the midpoint of the HERMOSA study because we realized how much work we had done and how satisfying it was." Working as UC Berkeley research assistants for the summer carried prestige in a community with very few opportunities for youth.

Academic Goals and Career Orientation:

One youth member reported that his initial understanding of a researcher was somebody sitting in a laboratory with a white coat and safety goggles. The idea that youth had the ability to conduct research was virtually unimaginable until they worked on the HERMOSA project. One youth stated, "You learn all this stuff in school, but getting to conduct research yourself is an opportunity we don't usually get, and I appreciate it."

Several students stated that their experience had helped shape their future career goals. Most hoped to attend college, but they would be the first generation in their family to do so. As one youth stated, "I've . . . gained knowledge on college and it has made me want to choose a major in environmental health." Another said, "I plan on majoring in environmental policy and minoring in legal studies. I want to help my community so it can be a better place and increase awareness." Recognizing the importance of supporting youth researcher goals, several meetings focused on college preparation. Of the 15 youth researchers who participated on the HERMOSA project team, 100% went on to college: seven were admitted to one of the University of California campuses, three to California state universities, and five to community colleges.

Challenges Faced:

Developing critical thinking, environmental health literacy, and leadership skills in youth through the use of participatory research presented difficulties for youth and adult research partners at times. As in other CBPR projects, particularly with youth,^{30,33} challenges identified by the adult and youth authors included time pressures and conflicting demands, when, for example, the youth researchers had major school examinations, extracurricular activities, and college application deadlines that conflicted with the HERMOSA project timetable. It was important to accommodate the youths' most compelling needs in these instances, while identifying compromise solutions so that the research activities could also proceed.

Another challenge involved the fact that, while the youth researchers, from the outset, expressed and actively demonstrated deep interest in the topic under investigation, the topic had been selected, and funding successfully sought, by adult researchers. Indeed, before their participation in this project, youth researchers were not aware that the personal care products that they use contain EDCs. The departure from “gold standard” CBPR—where the topic of study comes from the community—is common in youth-engaged studies.^{5,33} Indeed, Ozer, a leader in the field of youth participatory action research, has borrowed the concept of “bounded empowerment” from organizational theory to capture the dilemma. She suggests that efforts to promote project ownership and youth empowerment through CBPR need to work within the constraints of what schools and parents will permit, where the lengthy timetable for seeking and receiving grant funding for a proposed youth-involved research project is typically longer than the 9 month school year.³⁴

Finally, in the words of another participant observer, despite great interest among youth in the topic of EDCs in cosmetics, “pressing needs and issues of youth in Salinas were often present in the meetings, issues including lack of opportunities for youth, gang violence, and police brutality—but were not directly addressed in the project.” The YCC leader, however, made a point of discussing, at the beginning of sessions, recent police shootings and other disturbing events that may be on the youths' minds, yet not otherwise expressed. Such efforts to reinforce the HERMOSA adult partners' concerns for the youth of Salinas and their families and friends, well beyond their involvement in a particular project, was described by a long-term observer as in keeping with both the 14-year history of CHAMACOS and the YCC, and with the CBPR orientation in which this work was embedded. Consistent with the findings of others,^{5,6,33,35} we found that the research study and educational efforts needed to be developed and implemented with special attention to the lives, priorities, and competing obligations and interests of the youth researchers.

DISCUSSION:

We collaboratively conducted a CBPR study focusing on chemical exposures through cosmetics in order to advance environmental health literacy on this poorly appreciated topic, and build research, leadership, and advocacy skills in a group of 15 high school students in Salinas, CA. As previously reported, the HERMOSA experimental research showed that providing 100 Latina adolescents with the education and resources to switch from traditional personal care products to low chemical alternatives led to 25% to 45% reductions in body

burden concentrations of several EDCs.¹¹ Equally important, the results presented in this article show the impact of participation on the research team of 15 students who took part in this CBPR project. Through an analysis of regular written self-reflections, responses to open-ended survey questions, televised interviews, and participant observation by adult staff, the youth researchers exhibited increased environmental health literacy, leadership capacity, improved self-esteem, and academic goals and career orientation. Most impressively, all of the youth researchers from this underserved Latino immigrant community were accepted for admission to one or more colleges, including seven by the highly competitive University of California. Several youth, moreover, noted a desire to major in environmental health or related areas in large part because of their work with the project.

The small sample of this study ($n=15$), and the atypical nature of its members (i.e., self-nominated and then selected to participate in the CHAMACOS project's larger YCC), mean that the findings may not be generalizable but are likely reflective of the type of participants who took part. All of the 15 HERMOSA youth researchers, for example, had demonstrated the motivation to learn about, join, and stay actively engaged in the YCC, with most having participated in at least one other YCC-led CBPR project. Although many HERMOSA youth researchers thus commented on the ways in which participation in this study influenced their career goals and college aspirations, it is likely that at least some joined the YCC originally because of an interest in health or environmental health, and a desire to further improve their chances of getting into college.

The largely self-reported and observational nature of the study methods also precluded the demonstration of causal effects. A more rigorous study, with a larger, more representative sample and repeated measures analysis and a strong, in-depth qualitative study in which more systematic thematic analysis with interrater reliability could be conducted, would enable more robust data and data analysis. However, given the limited time and resources available, and the previously unexamined topic area that the HERMOSA study explored, the data collected suggest the utility of youth engagement in CBPR projects. As leading scholars in CBPR have pointed out, the participatory approach adds value to the experience of community members and researchers alike by improving the quality and reach of the research and advancing the understanding of new issues by community and academic partners as well as policy makers and the broader public.^{2,4,32} The engagement of youth in the HERMOSA study demonstrates the interaction and synergistic effects between designing and implementing an experimental study (on substituting low chemical cosmetic products), developing educational messaging, and the development of critical thinking skills in environmental health literacy for the youth researchers.

The gains in environmental health literacy in the youth researchers were evident in the progression to higher levels of critical thinking shown in Bloom's taxonomy, from "Recognition," as they learned about the EDCs in the products they used, to "Understanding," as they were able to share this information with their peers. Bloom's domain of "Application" was demonstrated when the youth researchers developed and carried out their educational campaign and forum to share results with their peers. Finally, the domains of Analysis, Evaluation, and Creation were illustrated in the youth's review of

the study findings and development of actions to promote access to low-chemical products (e.g., developing and circulating a petition and speaking to legislators).

Although the development of critical thinking is frequently cited as a goal of CBPR and indeed most educational programs, it is rarely explicitly assessed and there is little consensus about the most appropriate tool for its measure. The structured framework of Bloom's hierarchical taxonomy proved useful as an evaluation tool in our project. Significantly, Finn and O'Fallon¹⁸ raised concerns about the limits of Bloom's framework, including such questions as: Can increased environmental health literacy reduce exposure to environmental hazards to improve health? And does environmental health literacy improve health? The HERMOSA intervention is important because it demonstrated that, by integrating standard environmental health education into a CBPR approach, not only do students gain a more critical understanding of the real threat posed by exposures to EDCs, but they also become motivated to take action.

Part of the challenge of conducting CBPR is that the process must engage both academically trained researchers and community members in new ways of thinking. Research processes must be adjusted and adapted to enable community partners to learn the reasons why certain research methods are important, and conversely, for them to explain their concerns and perspectives to researchers. Since no evidence-based curriculum on how to educate youth on endocrine disruptors in cosmetics currently exists, lesson plans with new activities had to be developed, and we learned that engaging youth in conducting the research and actually measuring EDC exposures in their peers' urine made the materials come alive and the concern become real.

There is a long history of minority and low-income communities being disproportionately exposed to environmental hazards, indicating the need for vigilance to prevent this common pattern.³⁶ Often, there are multiple hazardous exposures that must be considered together to understand the brunt of the cumulative environmental injustices experienced.³⁷ At the same time, vulnerable communities often face many other pressing issues related to broader concerns with social inequity. In Salinas, these include youth violence, teen pregnancy, and high unemployment.³⁸ Other researchers have discussed the difficulties that may ensue when a topic of interest to academic researchers is chosen for a proposed study, yet may not be high on the priority list of the local community.³⁹ Although chemical exposure through cosmetics was not on the radar of Salinas teens, the opportunities provided by participation on the study team, and the lead academic researchers' skills in helping youth see both the relevance of this project to their personal lives and how simple tools (e.g., cell phone scanning of personal care products for their chemical content) helped open a new world of information gathering and build high youth interest in becoming involved.

In the absence of a regulatory system that ensures safety of consumer products, collaborative approaches that draw on the capabilities of nontraditional researchers show promise as an effective method to inform members of the public about how they can protect themselves and take action to reduce toxic exposures.

Acknowledgements:

The authors would like to thank all the CHAMACOS Youth Community Council (YCC) members for their dedication and support of this project. We thank Brenda Eskenazi and Asa Bradman for their work forming the CHAMACOS YCC and Patricia Wakimoto and James Nolan for their assistance with the manuscript.

Funding: This work was funded by grants 18BB-1800 from the California Breast Cancer Research Program, RD83451301 from the U.S. Environmental Protection Agency, and P01 ES009605 from the National Institute of Environmental Health Science.

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Table 1.

Bloom's Taxonomy of Educational Objectives applied to Environmental Health Literacy

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| <ol style="list-style-type: none">1. Recognize—awareness of the connection between environmental factors and health.2. Understand—knowledge of specific associations between environment and health, ability to repeat and rephrase.3. Apply—ability to re-organize and restate knowledge and execute tasks related to that knowledge (e.g. carry out research protocol).4. Analyze—use knowledge to assess environmental health information, compare, survey, and prioritize hazards and populations.5. Evaluate—use knowledge to determine environmental health context, recommend, judge, and critique strategies to avoid hazards.6. Create—use knowledge for action to reduce, mitigate, and adapt to environmental hazards. |
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Source: Adapted from Bloom's [Taxonomy of Educational Objectives](#)¹⁹ and Krathwohl's [A Revision of Bloom's Taxonomy: An Overview](#).³¹

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Table 2.

Participation of youth researchers in the HERMOSA study as they relate to the successive domains of Bloom’s Taxonomy.

Domain	Role of youth research & adult partners
Phase 1: Education to improve environmental health literacy and leadership skills.	
RECOGNIZE: Retrieve relevant knowledge from long-term memory.	<ul style="list-style-type: none"> • Academic researchers present topic through a hands-on exercise, and 12 youth, with some previous experience in environmental health research express interest in learning more and participating in the project
UNDERSTAND: Determine the meaning of instructional messages.	<ul style="list-style-type: none"> • Youth researchers (YRs) learn about EDCs in cosmetics and participate in exercises to explain the concepts in their own words. • YRs explore their own product use, and their awareness of chemicals in cosmetic products.
Phase 2+3: Designing and conducting the intervention.	
APPLY: Carry out or use a procedure in a given situation.	<ul style="list-style-type: none"> • General outline of study methods pre-set by researchers; YRs then discuss and help fine tune methods, based on their insider knowledge of what would likely be acceptable to youth participants in the community. • YRs assist in the development of study protocol • YRs develop a protocol for recruitment in the study • YRs recruit adolescent Latinas from their peer networks to participate in the HERMOSA study. • YRs lead the participant engagement by making phone calls and sending text messages to remind participants of forthcoming study visits. • YRs explain the overall purpose of the study and nature of the intervention to HERMOSA participants. YRs then have them select new products they will use and those they would discontinue using over the three day period. • YRs co-develop survey questions with UC Berkeley researchers • YRs pilot test study questionnaire instrument • YRs conduct HERMOSA study in Summer, 2013. Their tasks include: assessing cosmetics products participants used in their homes, greeting participants, guiding participants through study questionnaires, and explaining the intervention to participants.
ANALYZE: Break material into its constituent parts and detect how the parts relate to one another and to an overall structure or purpose	<ul style="list-style-type: none"> • YRs visit laboratory where urine samples were analyzed. • YRs enter data and review it with researchers. • YRs review and revise manuscripts to ensure accuracy and add their perspective to research articles.
Phase 4: From research to practice: Education and Advocacy.	
EVALUATE: Make judgments based on criteria and standards.	<ul style="list-style-type: none"> • YRs prepare and deliver presentations on the HERMOSA study to their peers and others in classrooms and at community gatherings. • YRs participate in presentations at scientific conferences and as part of several academic panels on youth- engaged research.
CREATE: Put elements together to form a novel, coherent whole or make an original product.	<ul style="list-style-type: none"> • YRs develop petition to encourage local store owners to carry low-chemical personal care products and get 439 signers. • YRs develop social media campaign to educate peers on EDCs in cosmetics.

Source: Adapted from Bloom’s [Taxonomy of Educational Objectives](#)¹⁹ and Krathwohl’s [A Revision of Bloom’s Taxonomy: An Overview](#).³¹