



The Impact of a Multi-Modal Childhood Lead Educational Intervention among Undergraduate Nursing Students in the United States

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Conflict of Interest

The authors declare that there is no conflict of interest.

Abstract

Background: Lead exposure and poisoning pose significant risks to public health. Effective educational intervention is needed to prepare nursing students to take an active role in response to this public health crisis. It is imperative that quality childhood lead poisoning prevention instruction be part of educating nursing students.

Objective: The purpose of this study was to describe and evaluate the effectiveness of a multi-modal childhood lead educational intervention.

Methods: A mixed methods study was implemented with 190 undergraduate community health nursing students from a Midwestern, urban, public university during fall 2019 and winter 2020 semesters. The control group (fall 2019 semester) consisted of students who received the existing curriculum while the intervention group (winter 2020 semester) consisted of students who received an additional pediatric lead exposure educational module. Pretest and posttest study surveys were completed. Quantitative and qualitative data underwent statistical and thematic analysis, respectively.

Results: Quantitative study results showed that scores increased from the pretest to the posttest for all participants in both the control and intervention groups (general lead exposure and poisoning knowledge $p < .05$; lead exposure knowledge, lead poisoning prevention knowledge, and total lead exposure and poisoning knowledge $p < .001$; and confidence in knowledge $p < .001$). However, the posttest means were statistically higher for students in the intervention group in the area of general lead exposure and poisoning knowledge ($p < .05$). Qualitative study results revealed what participants learned, found most helpful, and how they plan to apply and utilize this knowledge in their nursing practice.

Conclusions: This research demonstrates the effectiveness of the lead poisoning prevention educational intervention in increasing participants' knowledge of lead poisoning prevention and confidence in their knowledge levels.

Keywords: *lead poisoning; curriculum; community health nursing; public health nursing*

Background

Lead poisoning occurs when a person's health is negatively impacted by lead from contamination via contact, inhalation, or ingestion (Centers for Disease Control and Prevention [CDC], 2021). Lead exposure and poisoning represent a public health threat. Approximately 3.6 million homes in America with at least one child have substantial lead paint dangers (Hauptman et al., 2017). Questions regarding lead exposure are the most common questions received by professionals who work for North America's Pediatric Environmental Health Specialty Units (Hauptman et al., 2017). According to the 2018 Provisional Michigan Childhood Lead Poisoning Prevention Program Data Report, areas with a history of a high number of children with elevated blood lead levels (which in Michigan is defined as $\geq 5 \mu\text{g}/\text{dL}$ of blood), and where the Michigan Department of Health and Human Services (MDHHS) funds interventions to reduce the risk of lead exposure in children include: Adrian, Detroit, Flint, Grand Rapids, Hamtramck, Highland Park, Jackson, Lansing, and Muskegon (MDHHS, Division of Environmental Health, Childhood Lead Poisoning Prevention Program, 2020). According to the United Health Foundation (2021), homes in the Midwestern and Northeastern United States had the highest amount of lead-based paint and lead-based paint hazards. Individuals who live in poverty and those from communities of color who experience housing inequity are at a higher risk of lead exposure because they are more likely to live in older homes with lead-based paint (CDC, 2020b). Lead exposure is especially of concern in low and middle-income countries as well, including but not limited to Mexico, China, India, Philippines, and Nigeria (Kordas et al., 2018).

Young children are at highest risk of lead poisoning because of their developing brains and small size (CDC, 2020b). Sources of lead include lead-based paint chipping usually found in homes built before 1978, some toys and toy jewelry, imported candies, and certain water pipes (CDC, 2020c). Lead exposure can have a negative effect on health and even low levels have been shown to reduce children's IQs, ability to concentrate, and academic success; however, lead poisoning is preventable which includes removing sources of lead exposure (primary prevention) and blood lead testing (secondary prevention) (CDC, 2020a). Goals of Healthy People 2030 related to environmental health are to reduce exposure to lead and reduce blood lead levels in children (United States Department of Health and Human Services, Office of Disease Prevention and Health Promotion, n.d.). Prevention of pediatric lead exposure is essential and this problem rests largely in part on public health departments (Michel et al., 2020).

Public health nurses often work with environmental health personnel as part of a multidisciplinary approach to lead poisoning prevention. It is important for nurses to know how to

assess for environmental health risks and educate on how to decrease risks, yet nurses' knowledge of the environment and environmental threats to health needs to be improved (Stanhope & Lancaster, 2018). Given that nurses make up the single largest group of healthcare workers, it is imperative that they can recognize and address environmental hazards, and knowledge of environmental health concepts is essential to nursing practice (American Nurses Association, 2007). Tohidi et al. (2019), found that utilization of electronic self-learning modules can improve nursing students' clinical competency and be helpful in asynchronous learning. Morrison et al. (2017) found that although existing literature has shown that nursing students have a knowledge deficit of childhood lead poisoning risk factors, and more education could be appropriately integrated into the community health course of the nursing program curriculum, research regarding nursing students' perception of risk factors for childhood lead poisoning is still lacking.

The Flint water and Detroit lead crisis presented a window of opportunity to provide nursing students with the lead knowledge, skills, and abilities necessary to be effective nurses and prepare them to play a role in public health emergency response. In this lead initiative, the study team provided students with a lead exposure prevention module to introduce students to various forms of lead exposures, as well as to various response skills essential to address this critical public health issue.

The purpose of this study was to describe and evaluate the effectiveness of a multi-modal childhood lead educational intervention. The following research questions were examined: 1) Do students' scores increase from the pretest to the posttest, indicating an increase in knowledge as a result of the educational intervention? 2) Is the addition of a lead module to the existing curricular materials more effective than the use of the existing curricular materials only? This study will help to fill gaps in the literature by assessing community health nursing students' lead exposure and poisoning knowledge and confidence levels, and will also contribute to the existing, minimal body of literature on this topic.

The main theoretical framework for this study was Nightingale's Theory of Nursing Practice, which indicates that environmental quality influences health and healing (Stanhope & Lancaster, 2018). This theory serves as the theoretical framework, specifically the principle of environmental alteration (Selanders, 2010). In this theory, Nightingale indicates that environmental factors can be altered to improve conditions that facilitate health and healing (Selanders, 2010). This theoretical framework relates to this study in that changing the environment by removing lead exposures can prevent lead poisoning and its complications, and thus promote human flourishing. An educational theory that also supports this research is Knowles' Adult Learning Theory (1984), which

indicates that adults prefer meaningful learning experiences with applicability to their career. This theory relates to this study in that the nursing students are adults and the information they are learning has relevance to their nursing career; this theory also relates in that it is a multi-modal theory and this study involves evaluation of a multi-modal childhood lead educational intervention (Knowles, 1984).

Methods

This study utilized a mixed methods design to evaluate a multi-modal childhood lead educational intervention among community health nursing students. The quantitative component of this study was quasi-experimental and examined whether students' scores increased from the pretest to the posttest, indicating an increase in knowledge of lead exposure and lead poisoning prevention, as well as an increase in confidence in knowledge levels resulting from the educational intervention. The qualitative component of this study was evaluative and utilized students' responses to a questionnaire to understand what they learned, found most helpful, and how they plan to apply and utilize this knowledge in their nursing practice. The use of both quantitative and qualitative study components provided a more complete understanding and strengthened the study. Approval to conduct this study was obtained from the University Human Subjects Review Committee/Institutional Review Board (UHSRC-FY19-20-72). Purposive sampling was utilized.

The study sample ($N = 190$) consisted of undergraduate, community health nursing students from multiple nursing program types at a Midwestern, urban, public university during fall 2019 and winter 2020 semesters. The fall 2019 semester cohort represented the control group and the winter 2020 semester cohort represented the intervention group. This study included community health nursing students in the following Bachelor of Science in Nursing (BSN) programs: traditional (where nursing is their first degree), second-degree (where they have a non-nursing primary degree), collaborative (where they complete two years at a community college and two years at the university), and completion (RNs with an associate degree returning for their BSN). Data collection was completed in person with students during fall 2019 semester and online with students during winter 2020 semester using Qualtrics Survey Software.

All students were required to complete the educational activities as part of their community health nursing coursework. Students completed a consent form one week prior to beginning the unit on environmental health and disaster management under which lead poisoning prevention was covered. Immediately after completing a consent form, students completed a pretest consisting of demographic questions that assessed gender, nursing program type, and whether they currently work in healthcare and if so, what capacity. The pretest also included quantitative content ques-

tions using the Nursing Students Lead Knowledge and Confidence Scale (NS-LEKS). The NS-LEKS consists of items adapted from the Chicago Lead Knowledge Test (Rabito et al., 2004) and Chinese Lead Knowledge Test (Huang et al., 2017), for which validity and reliability were established, and assessed students' general knowledge about lead exposure and lead poisoning prevention, knowledge specific to lead exposure, knowledge specific to lead poisoning prevention, and confidence in their knowledge levels.

In terms of standard content for the unit on environmental health and disaster management, students in both the control group (fall 2019 semester) and the intervention group (winter 2020 semester) received an interactive PowerPoint presentation on Environmental Health and Disaster Management. They were assigned the corresponding chapters in their community/public health nursing textbook, articles regarding notable natural and manmade disasters, and a video about asbestos contamination. Students in the intervention group (winter 2020 semester) were additionally assigned the Pediatric Environmental Health Specialty Units (PEHSU) e-learning module titled, "Pediatric Lead Exposure: Diagnosis, Management and Prevention," which covered diagnosis, management, and prevention of pediatric lead poisoning as a result of environmental exposures (PEHSU, 2017).

Students then completed a posttest one week after the unit on environmental health and disaster management concluded. The posttest contained all the same questions from the pretest with the addition of independently developed qualitative evaluative questions that only appeared on the posttest. The qualitative evaluative questions assessed what students learned that they did not know before about lead poisoning and prevention; what they found most helpful to learn about lead poisoning and prevention and why; how they plan to apply and utilize this knowledge in their nursing practice; and any additional comments or suggestions.

The quantitative data were analyzed using Statistical Package for the Social Sciences version 25. The qualitative data underwent thematic analysis.

Results

Quantitative

Participant Demographics

The participants consisted of community health nursing students ($N = 190$) at a Midwestern, urban, public university. Descriptive frequencies revealed that the majority of participants were female (87.9%), prelicensure students in the traditional, second degree, or collaborative BSN program (68.4%), and currently work in healthcare (73.8%). For those who currently work in healthcare, the largest capacity for prelicensure students was Patient Care Technician (28.7%) and for postlicensure students was RN (44.1%). See Table 1 for demographics for study participants.

Table 1*Demographics for All Participants*

Demographic Characteristic	<i>n</i>	%
Gender		
Female	167	87.90%
Male	22	11.60%
Prefer Not to Reply	1	0.50%
Nursing Program		
BSN-Traditional	74	38.90%
BSN-Second Degree	35	18.40%
BSN-Collaborative	21	11.10%
BSN-Completion	60	31.60%
Current Healthcare Work		
Yes	141	73.80%
No	49	25.70%
Main Healthcare Work Capacities		
Prelicensure-Patient Care Technician	39	28.70%
Postlicensure-RN	60	44.10%

Impact of Lead Education on All Study Participants

Paired samples t-tests of the pretest and posttest means revealed that participants' scores increased from the pretest to the posttest (meaning more correct responses on the posttest than the pretest) indicating an increase in knowledge levels in all areas of: general lead exposure and poisoning knowledge, lead exposure knowledge, lead poisoning prevention knowledge, and total lead exposure and poisoning knowledge, which were all statistically significant (general lead exposure and poisoning knowledge $p < .05$ and lead exposure knowledge, lead poisoning prevention knowledge, and total lead exposure and poisoning knowledge $p < .001$). Pretest and posttest means also revealed that participants' confidence in their knowledge levels increased from the pretest to the posttest, which was also statistically significant ($p < .001$). Increases in lead knowledge levels and confidence in knowledge indicate that the educational intervention was effective. See Table 2 for pretest and posttest means with statistical significance for all participants.

Comparison of Impact Between Control and Intervention Groups

Pretest and posttest means were higher for students in the intervention group compared to students in the control group in the areas of lead poisoning prevention knowledge, total lead exposure and poisoning knowledge, and confidence in knowledge, which were statistically significant ($p < .05$). The posttest mean was higher for students in the intervention group compared to students in the control group in the area of general lead exposure and poisoning knowledge and this finding was statistically significant ($p < .05$). Pretest means for students in the intervention group may have been higher because there were practicing RNs in that group but not the control group. Posttest means for students in the in-

tervention group were likely higher due to the addition of the lead module to the existing curricular materials that semester; however, the mixed participant groups may affect the accuracy of the results on the effect of the difference in educational modes. See Table 3 for pretest and posttest means by control group (fall 2019 semester) versus intervention group (winter 2020 semester).

Qualitative***Information Learned About Lead Poisoning and Prevention***

In response to the question of what participants learned that they did not know before about lead poisoning and prevention, the first theme identified was sources of lead exposure. Examples of participant responses included: "Increased water temperature increases lead leaching," "Houses built before 1978 are more likely to have lead risks," and "I learned that imported pottery and jewelry can contain lead." Another example of a participant response included: "I also learned there are many ways that lead can make it to the home, like on people's work attire. Lead is almost like bacteria a health-care worker can bring home."

A second theme identified was signs and symptoms of lead poisoning and its effects. Examples of participant responses included: "Signs and symptoms to look for," and "That it can affect a child's IQ and ability to focus."

A third theme identified was screening and diagnosis, especially pertaining to lead levels. Examples of participant responses included: "I learned a lot about the levels of lead poisoning in bodies and how there is no safe level," and "I was unaware about serum blood levels of lead that were considered dangerous. I didn't realize how these recommendations were created either."

Table 2*Pretest and Posttest Means with Statistical Significance for All Participants*

Area/Category	Pretest Mean	Posttest Mean	Significance
General Lead Exposure and Poisoning Knowledge	92.97	95.24	0.021*
Lead Exposure Knowledge	79.06	83.39	0.000**
Lead Poisoning Prevention Knowledge	69.55	80.13	0.000**
Total Lead Exposure and Poisoning Knowledge	80.55	85.75	0.000**
Confidence in Knowledge	9	11.4	0.000**
* $p < 0.05$			
** $p < 0.001$			

Table 3*Pretest and Posttest Means by Semester*

Area/Category		Cohort		Significance
		Fall 2019	Winter 2020	
		Mean	Mean	
General Lead Exposure and Poisoning Knowledge	Pretest Mean	91.84	93.49	0.354
	Posttest Mean	92.18	96.67	0.031*
Lead Exposure Knowledge	Pretest Mean	78.13	79.49	0.058
	Posttest Mean	82.64	83.73	0.481
Lead Poisoning Prevention Knowledge	Pretest Mean	63.60	72.34	0.001*
	Posttest Mean	76.00	82.06	0.036*
Total Lead Exposure and Poisoning Knowledge	Pretest Mean	78.26	81.59	0.001*
	Posttest Mean	83.65	86.7	0.012*
Confidence in Knowledge	Pretest Mean	8.56	9.28	0.032*
	Posttest Mean	10.80	11.66	0.025*
* $p < 0.05$				

A fourth theme identified was prevention of lead poisoning, especially pertaining to diet. Examples of participant responses included: “That having a diet rich in vitamin C, calcium, and vitamin D is good to prevent the absorption of lead,” and “How nutrition is important in decreasing lead absorption.”

The fifth and final theme identified was policy and state-wide issues. An example of a participant response included: “More detailed information about how lead policy differs across states.”

Most Helpful Information Learned About Lead Poisoning and Prevention

Concerning the question of what participants found most helpful to learn about lead poisoning and prevention and why, the first theme identified was utilization of this information for application in practice with patients and in personal life with families. An example of a participant response regarding application in practice with patients included: “I think it will be helpful to educate my future patients and families,” and an example of a participant response regarding application in personal life included: “Education around children because I have children.”

A second theme that was identified was everything/all information. Examples of participant responses included: “Everything I learned was most helpful because it is all equally relevant to prevent lead exposure in children and adults,” and “Everything was helpful. The information was intriguing and informative to ensure children’s safety.”

A third theme identified was various learning modalities, with the video module emerging as its own subtheme. In regard to the theme of various learning modalities, examples of participant responses included: “Powerpoint + book. I learn well from reading,” “The movie presented facts in an easy way,” and “Taking the pre and posttest because it showed me how much I did or didn’t know about lead exposure.” Regarding the subtheme of the video module, examples of participant responses included: “I thought the video module was helpful. It went over a lot of things I did not know about lead exposure,” “The video you had us watch. This is because it explained things very well and then tested our knowledge at the end,” and “The video was very informative. Had lots of info.”

Application and Utilization of This Knowledge in Nursing Practice

In reference to the question of how participants plan to apply and utilize this knowledge in their nursing practice, the first theme identified was educating patients, especially around prevention, particularly avoiding exposure. Examples of participant responses included: “I will educate my patients on the dangers of lead,” and “I plan to use this informa-

tion to educate to prevent lead poisoning.”

A second theme identified was recognizing signs and symptoms. Examples of participant responses included: “Watch for signs and symptoms of lead poisoning,” and “To know what symptoms to look for in a child with lead poisoning and factors that can contribute.” Another example of a participant response pertaining to a combination of the first and second themes included: “I plan to use my knowledge I learned during this activity to practice primary and secondary prevention with my patient population to reduce the risk of exposure and decrease the chances or incidence of the harmful effects lead poisoning causes.”

A third theme identified was surveillance and monitoring. An example of a participant response included: “More closely monitoring for lead in patients.”

An additional theme that emerged was participants feeling it was not applicable to them in their current or projected nursing practice setting. An example of a participant response included: “I plan to work in adult critical care, so I’m not sure how I will use this information on a daily basis.”

Additional Feedback Regarding the Educational Intervention

Regarding the question of any additional comments or suggestions, most participants indicated that they did not have any additional comments or suggestions, for example, by noting not applicable (N/A). However, the theme of appreciation and support for this information was identified. Examples of participant responses included: “Thank you!” “I found this program very useful and beneficial,” and “I found it informative and educational. I like that questions are clear and to the point.”

Discussion

This study is one of the few studies in existing literature that described and examined the impact of a multi-modal educational intervention to prepare nursing students in addressing the timely public health crisis. The educational intervention (the standard environmental health and disaster management unit, and the pediatric lead exposure e-learning module) improved participants’ knowledge of lead exposure and lead poisoning prevention, as well as participants’ confidence in their knowledge levels. The quantitative findings were further strengthened with participants’ responses that indicated how the educational intervention improved their knowledge of lead poisoning prevention and their behavioral intent. Particularly pertaining to what participants found most helpful, themes from the responses showed various learning modalities increased participants’ knowledge and behavioral intent in taking nursing interventions to prevent lead exposure and lead poisoning. In addition, the subtheme of the video module indicated that while participants felt

that the existing curriculum was helpful, their education was positively augmented by the addition of a pediatric lead exposure e-learning module as it further improved their knowledge of lead exposure and lead poisoning prevention.

The existing literature identified knowledge deficits of childhood lead poisoning among nursing students and supports more education on childhood lead poisoning in nursing program curriculum, as well as a need for research focusing on nursing students' knowledge of childhood lead poisoning (Morrison et al., 2017). According to this study's main theoretical framework, Nightingale's Theory of Nursing Practice, it appears that this educational intervention was effective in educating community health nursing students on how to positively alter the environment by educating the public about sources of lead exposure, lead testing, and prevention of lead exposure and lead poisoning. In relation to this study's supportive theoretical framework, Knowles' Adult Learning Theory, it seems that most students found the educational intervention to be valuable and relevant to their career. This study fills the gap by providing evidence on how educational intervention improved nursing students' knowledge of childhood lead poisoning, thereby contributing to the body of literature on this topic. Additionally, results of this study can improve the lead-based education given to the public, thereby promoting their health and helping to prevent and decrease lead exposure and lead poisoning.

A potential limitation to this study could include the mixed participant groups between the control group (fall 2019 semester) which consisted of prelicensure students only and the intervention group (winter 2020 semester) which consisted of pre- and postlicensure students, and the greater number of students (approximately double) in the intervention group (winter 2020 semester). Another potential limitation could include that this study has a relatively small sample, which may limit the generalizability of the findings. However, given that this study utilized a mixed methods approach, it is more comprehensive than the use of a single method, and strengthens the study, helping to counteract the small sample study limitation. An additional limitation could include the Coronavirus disease of 2019 (COVID-19) pandemic that occurred between the semesters, which may have had an impact on participants in the intervention group (winter 2020 semester), in that results may have been even more positive if this study was conducted at a time without the impact of the COVID-19 pandemic.

More research is needed in this area. Future plans include piloting the addition of a state-specific developed lead module and expanding community-based education with community-based organizational partnerships.

Conclusions

The purpose of this mixed methods study was to describe and evaluate the effectiveness of a multi-modal childhood lead educational intervention. This study indicates that the educational intervention was effective, and the participant feedback shows support for the usefulness of this information. This research advances the science by helping to improve the lead-based education provided to community health nursing students.

References

- American Nurses Association. (2007). *ANA's principles of environmental health for nursing practice with implementation strategies*. <http://ojin.nursingworld.org/MainMenuCategories/WorkplaceSafety/Healthy-Nurse/ANAsPrinciplesofEnvironmentalHealthforNursingPractice.pdf>
- Centers for Disease Control and Prevention. (2020a). *Health effects of lead exposure*. <https://www.cdc.gov/nceh/lead/prevention/health-effects.htm>
- Centers for Disease Control and Prevention. (2020b). *Populations at higher risk*. <https://www.cdc.gov/nceh/lead/prevention/populations.htm>
- Centers for Disease Control and Prevention. (2020c). *Sources of lead*. <https://www.cdc.gov/nceh/lead/prevention/sources.htm>
- Centers for Disease Control and Prevention. (2021). *Blood lead levels in children*. <https://www.cdc.gov/nceh/lead/prevention/blood-lead-levels.htm>
- Hauptman, M., Bruccoleri, R., & Woolf, A.D. (2017). An update on childhood lead poisoning. *Clinical Pediatric Emergency Medicine*, 18(3), 181-192. <https://doi.org/10.1016/j.cpem.2017.07.010>
- Huang, R., Ning, H., Baum, C.R., Chen, L., & Hsiao, A. (2017). "What do you know?"— Knowledge among village doctors of lead poisoning in children in rural China. *BMC Public Health*, 17, Article 895. <https://doi.org/10.1186/s12889-017-4895-2>
- Knowles, M. (1984). *Andragogy in action: Applying modern principles of adult learning*. Jossey-Bass.
- Kordas, K., Ravenscroft, J., Cao, Y., & McLean, E.V. (2018). Lead exposure in low and middle-income countries: Perspectives and lessons on patterns, injustices, economics, and politics. *Journal of Environmental Research in Public Health*, 15(11), 2351. <https://doi.org/10.3390/ijerph15112351>
- Michel, J.J., Erinoff, E., & Tsou, A.Y. (2020). More guidelines than states: Variations in U.S. lead screening and management guidance and impacts on shareable CDS development. *BMC Public Health*, 20, Article 127. <https://doi.org/10.1186/s12889-020-8225-8>
- Michigan Department of Health and Human Services, Di-

- vision of Environmental Health, Childhood Lead Poisoning Prevention Program. (2020). *2018 Provisional annual report on childhood lead testing and elevated levels: Michigan*. https://www.michigan.gov/documents/lead/2020.02.24_CLPPP_2018_Provisional_Report_Published_681911_7.pdf
- Morrison, S., Ressler, E., Sheets, K., & Abraham, S. (2017). Nursing students' perception of childhood lead poisoning risk factors. *International Journal of Studies in Nursing*, 2(2), 37-43. <https://doi.org/10.20849/ijns.v2i2.216>
- Pediatric Environmental Health Specialty Units. (2017). *Pediatric lead exposure: Diagnosis, management and prevention*. <https://www.pehsuclassroom.net/learn/course/external/view/elearning/77/pediatric-lead-exposure-diagnosis-management-and-prevention>
- Rabito, F.A., Sarpy, S.A., Shorter, C., & Iqbal, S. (2004). Lead prevention knowledge among low-income urban residents: The Chicago lead knowledge test revisited. *Journal of Children's Health*, 2(1), 11-20. <https://doi.org/10.3109/15417060490453236>
- Selanders, L.C. (2010). The power of environmental adaptation: Florence Nightingale's original theory for nursing practice. *Journal of Holistic Nursing*, 28(1), 81-88. <https://doi.org/10.1177/0898010109360257>
- Stanhope, M., & Lancaster, J. (2018). *Foundations for population health in community/public health nursing* (5th ed.). Elsevier.
- Tohidi, S., KarimiMoonaghi, H., Shayan, A., & Ahmadiania, H. (2019). The effect of self-learning module on nursing students' clinical competency: A pilot study. *Iranian Journal of Nursing and Midwifery Research*, 24, 91-95.
- United Health Foundation. (2021). *Housing with lead risk*. https://www.americashealthrankings.org/explore/health-of-women-and-children/measure/housing_leadrisk/state/ALL
- United States Department of Health and Human Services, Office of Disease Prevention and Health Promotion. (n.d.). *Environmental health*. <https://health.gov/healthy-people/objectives-and-data/browse-objectives/environmental-health>