Environmental influences on agricultural worker health

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Pesticides and agricultural worker health

Pesticides are used extensively in farm working communities to control harmful pests and prevent crop yield loss. Each year, an estimated one billion pounds of pesticides are applied to U.S. farms, forests, lawns and golf courses. More than 17,000 pesticide products are currently on the market. Adults and children from farm-working communities have significantly higher risk for exposure to harmful pesticides compared to their non-farming counterparts.1-6 Pesticide compounds enter the body via multiple routes of exposures including ingestion, inhalation, and/or dermal contact. Pesticides are generally classified by their chemical properties (Table 1), with each class affects health through different biologic mechanisms.

Table 1. Commercially available pesticides by chemical class.

Pyrethroids	Organophosphates	Organochlorines	Carbamates	Dicarboximides	Organonitrogen	Other
Bifenthrin	Chlorfenvinphos	Chlorothalonil	Carbaryl	Captan	Aldicarb	Bromopropylate
Cypermethrin	Chlorpyriphos	a-Endosulfan	Fenoxycarb	Iprodione	Benomyl	(Benzilate,
Deltamethrin	Chlorpyriphos-	ß-Endosulfan			Carbendazim	Acaricide)
Permethrin	Methyl	Endosulfan-			Carbofuran	Buprimate
Resmethrim	Dimethoate	Sulfate			Chlorprophan	(Pyrimidine,
Sumithrin	Omethoate	Lindane			Diuron	Fungicide)
	Phosalone	Tetradiphon			(herbicide)	Metalaxyl
	Pirimiphos-	p.p.-DDT			Formetanate	(Acylalanine,
	Methyl	p.p.-DDE			Methiocarb	Fungicide)
	Triazophos				Methomyl	Thiophanate-
					Oxamyl	Methyl
					Propham	(fungicide)
					Propoxur	
					Thiobencarb	

Due to high biological activity (e.g., endocrine disruption, nerve suppression) and in many cases, long persistence in the environment (i.e., organochlorine), pesticides have been linked to many undesirable human health effects ranging from acute, sub-chronic to chronic effects (Table 2).[7-10]

Table 2. Selected health outcomes associated with pesticide exposures

Unborn babies	Children	Farmers/adults
Birth defects	Brain cancer	Non-Hodgkin's Lymphoma
Autism	Leukemia	Parkinson's Disease
Delayed development	Asthma	Low sperm count
ADHD	Poor neurobehavioral development	Cancer
Restricted growth	Respiratory diseases	Skin, eye, lung irritation
Preterm birth	Skin, eye, lung irritation	Genotoxicity
	Genotoxicity	

In agricultural communities, pesticide exposure is attributed to higher rates of birth adverse birth outcomes (discussed later in 'Pregnancy outcomes in farm working communities'), developmental delays[11-13], respiratory complications, and cancer among children[14]. Among adults, chronic exposures to pesticides have been linked to genotoxicity,[15] declined neuropsychological functioning[16-23], various types cancer[24-29], poor mental health[30], respiratory complications[31,32], and cardiovascular diseases[33]. Although many pesticides associated with reproductive effects are no longer widely used in the US, employment in agriculture appears to be associated with activation of physiological biological and pathological processes that may lead to infertility[7,34]. Acute exposure to these chemical compounds can lead to immediate toxicological symptoms, including watery eyes, coughing, running nose, dizziness, muscle ache, nausea, and seizures[35].

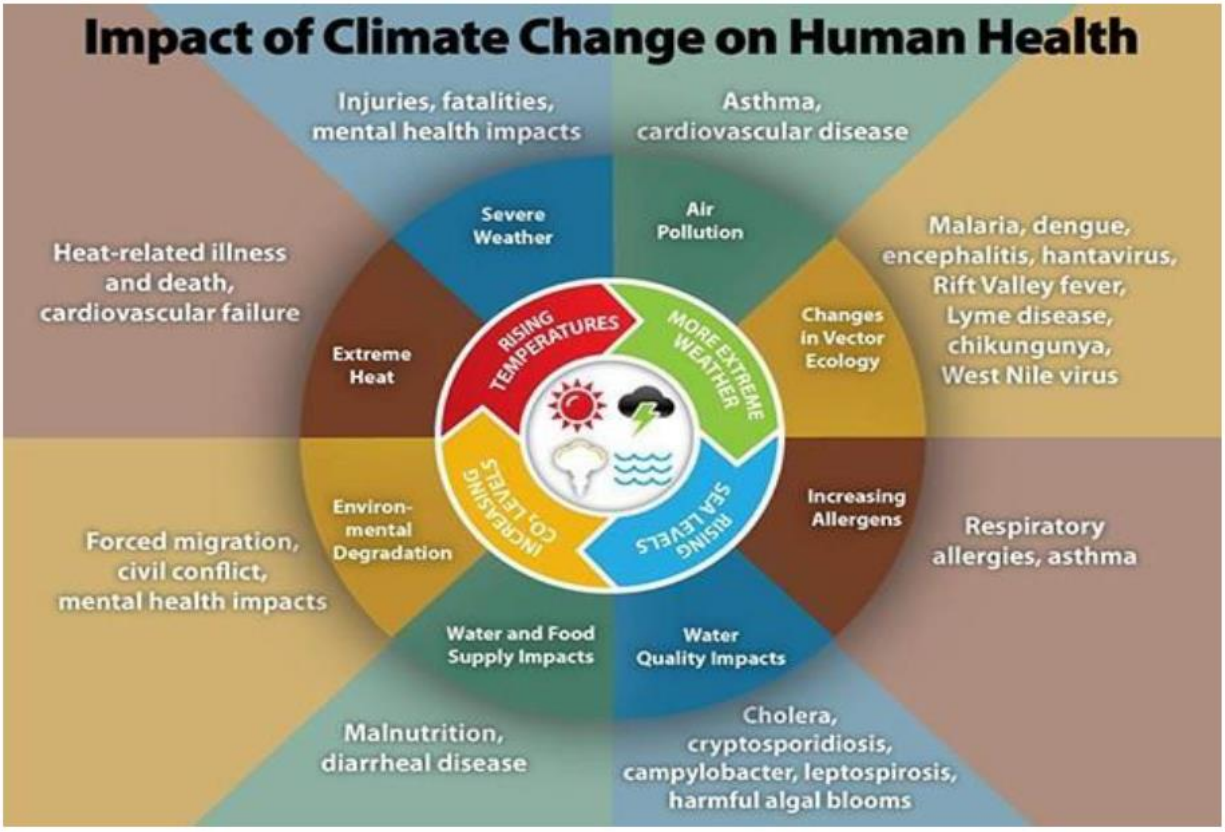
Despite higher exposure to pesticides compared to non-farming communities, there is a significant level of risky behaviors among pregnant agricultural workers related to hand-washing, bathing, protective clothing, house cleaning, and eating produce from the field[36]. Agricultural workers are usually unaware of the pesticides they are exposed to, their health effects, nor the laws that aim to protect them from exposure. They are insufficiently informed to take the necessary precautions to protect them against the risks, and often do not know the nature of their illness and are motivated to keep working to support their families. Even physicians are not well-trained to recognize and manage health outcomes related to pesticide exposures.

Although there has been significant attention to the health effects of pesticides on human health, there has been little focus on the vulnerable agricultural worker population, and significant methodologic barriers make these studies extremely difficult to conduct. The leading obstacles are difficulties in establishing the population at risk and access to health information. Many existing studies on agricultural communities suffer from small sample size. UC Merced is located within an agricultural community and is well positioned to study health effects of pesticides exposures among this vulnerable population, which include a large proportion of migrant workers, whose representation in existing research is significantly limited.

Climate change and health in agricultural communities

Climate change is the biggest public health threat of the 21st century and is predicted to cause dramatic changes in the environment, especially increased episodes of heat, severe weather, dust and allergens.[37] In addition to agricultural effects,[38] despite human's ability to acclimate, climate change has been linked to a myriad of health effects ranging from injury to cardiorespiratory diseases, infectious disease, mental health and even death. Multiple pathways have been suggested to explain the health effects of climate change (Figure 1),[39-46] and the farm working community is one of the first to be affected given the nature of their work.

Figure 1. Pathways by which climate change affects health



Despite concerted attention on the health effects of climate change, very little is being addressed at this time on the effects of climate change on occupational risks of farmers and agricultural workers due to multiple reasons. The informal, seasonal, and subcontracted nature of agricultural labor makes it difficult to count agricultural workers. Undocumented agricultural workers and their employers may be reluctant to share information. In addition, workers with health concerns may not report their experiences due to lack of reporting systems, fear of retaliation, or failure to recognize symptoms. The lack of accurate and complete data makes every aspect of research, education, and advocacy on agricultural worker issues more difficult. More importantly, effective public health interventions to protect the health of this vulnerable population cannot be implemented.

Lastly, because agriculture is both vulnerable to changes in climate and a significant source of greenhouse gases, research supporting coordinated adaptation and mitigation initiatives in this population is critical. However, perceived risk in climate change among farmers is not optimal, and that few endorse greenhouse gas reduction, suggesting that more outreach and community-based efforts to gain their trust are necessary. [47,48]

Pregnancy outcomes among agricultural workers

As previously discussed, the agricultural industry has some of the highest incidence rates of occupational injuries and illnesses resulting from accidents, falls, excessive heat, repetitive motion and adverse pesticide exposure [49,50]. Although the incidence of adverse pregnancy outcomes among female agricultural workers is not clear, women agricultural workers and their fetuses may have increased risk of negative health outcomes due to environmental and occupation risk factors.[51]

While a few studies failed to demonstrate an association between farm working related exposures and adverse pregnancy outcomes,[52,53] many more have shown the contrary. Exposures to agricultural pesticides related with farm working is consistently linked to increased time to pregnancy [51,54-56](i.e. decreased fecundability), as well as infertility[57]. For those who can conceive, newborns of farmers have higher risk of preterm delivery, low birthweight, small for gestational age.[58] Maternal employment in agriculture is associated with various types of birth defects[59-63] including limb defect,[64] orchidopexies,[65] spina bifida.[66] In ten agricultural counties of California, proximity to commercial pesticide applications was associated with an elevated risk of fetal death due to congenital anomalies with the largest risks for fetal death due to congenital anomalies were from pesticide exposure during the 3rd-8th weeks of gestation. [67,68]

Studies have shown that female agricultural workers are generally aware that exposures to pesticides and other occupational hazards affect pregnancy and child health; however, they report not receiving information about these specific risks in mandated pesticide training nor, do health care providers routinely discuss these issues with them during pregnancy.[69] They also report lack of control over workplace conditions[70]. Interviews with rural health care providers reveal limited knowledge about agricultural work or occupational and environmental health risks during pregnancy.[71]

Many studies on pregnancy-related outcomes among agricultural workers focus on fetal/reproductive outcomes as described. A pregnant woman goes through multiple complex physiological and psychological changes to accommodate the fetus and is also vulnerable to occupational risks related to farm working.

Gestational complications including gestational hypertension, gestational diabetes, cardiovascular diseases, and asthma are increasingly common disorders of pregnancy in the general populations.[72-76] However, to date, no study has examined these outcomes among farm working pregnant women.

More recently, paternal exposures to environmental hazards within farming communities have also been implicated with respect to pregnancy outcomes and merit attention.[57,59,66] As the agricultural

communities become more diverse, and known risk factors for pregnancy outcomes (e.g., maternal age, chronic diseases) become more prevalent, it is critical to learn more about pregnancy outcome in this vulnerable population.

Air quality in agricultural workers communities

There are few studies that examine the impact of air quality in agricultural worker communities. The only study conducted on the realm of air quality was focused on childhood asthma and ecosyndemics that could be attributed to air pollution exposure. [77] The study used ethnographic and photovoice methods to demonstrate how industrial farming conditions expose children of agricultural workers to environmental pollutants such as bovine contamination, agricultural burning, pesticide exposure, and substandard housing. The student found that children of Mexican-origin agricultural workers in the San Joaquin Valley have higher rates of asthma compared to children of Mexican descent in both United States and Mexico. Left unanswered is the question of whether overall air pollution exposure is higher in farming communities than urban places in California. Also unknown is whether there is more dust exposure in agricultural worker communities, whether the air pollution exposure varies by crop type (for example almond growing vs other crops), and whether industrial farming creates greater pollution exposure to agricultural worker communities.

Water Quality and agricultural workers

There is also a lack of research regarding water quality in agricultural worker communities. Only two studies were found: One focused on Total Coliform in agricultural worker camps in North Carolina and a second examining drinking water disparities among long income and minority communities including small communities in agricultural areas. The studies suggest that water supplied to agricultural worker camps often did not comply with current federal standards. Total coliform bacteria were found in 61 camps with Escherichia coli detected in 2.[78] There were reports that documented a lack of piped water systems or serious water quality problems in low income and minority communities. [79] Left unanswered are the current conditions of water quality for agricultural workers in the agricultural regions of California, including the risks from drinking contaminated water and the disparities in drinking water quality across the state.

References

1) Lopez-Galvez N, Wagoner R, Quiros-Alcala L, et al. Systematic Literature Review of the Take-Home Route of Pesticide Exposure via Biomonitoring and Environmental Monitoring. Int J Environ Res Public Health. 2019;16(12).

2) Harley KG, Parra KL, Camacho J, et al. Determinants of pesticide concentrations in silicone wristbands worn by Latina adolescent girls in a California farmworker community: The COSECHA youth participatory action study. Sci Total Environ. 2019;652:1022-1029.

3) Glorennec P, Serrano T, Fravallo M, et al. Determinants of children's exposure to pyrethroid insecticides in western France. Environ Int. 2017;104:76-82.

4) Hyland C, Laribi O. Review of take-home pesticide exposure pathway in children living in agricultural areas. Environ Res. 2017;156:559-570.

5) Deziel NC, Friesen MC, Hoppin JA, Hines CJ, Thomas K, Freeman LE. A review of nonoccupational pathways for pesticide exposure in women living in agricultural areas. Environ Health Perspect. 2015;123(6):515-524.

6) Quiros-Alcala L, Bradman A, Nishioka M, et al. Pesticides in house dust from urban and farmworker households in California: an observational measurement study. Environ Health. 2011;10:19.

7) McCauley LA, Anger WK, Keifer M, Langley R, Robson MG, Rohlman D. Studying health outcomes in farmworker populations exposed to pesticides. Environ Health Perspect. 2006;114(6):953-960.

8) Frank AL, McKnight R, Kirkhorn SR, Gunderson P. Issues of agricultural safety and health. Annu Rev Public Health. 2004;25:225-245.

9) Calvert GM, Plate DK, Das R, et al. Acute occupational pesticide-related illness in the US, 1998-1999: surveillance findings from the SENSOR-pesticides program. Am J Ind Med. 2004;45(1):14-23.

10) Damalas CA, Koutroubas SD. Farmers' Exposure to Pesticides: Toxicity Types and Ways of Prevention. Toxics. 2016;4(1).

11) Lu C, Essig C, Root C, Rohlman DS, McDonald T, Sulzbacher S. Assessing the association between pesticide exposure and cognitive development in rural Costa Rican children living in organic and conventional coffee farms. Int J Adolesc Med Health. 2009;21(4):609-621.

12) Eskenazi B, Marks AR, Bradman A, et al. Organophosphate pesticide exposure and neurodevelopment in young Mexican-American children. Environ Health Perspect. 2007;115(5):792-798.

13) Eskenazi B, Marks AR, Bradman A, et al. In utero exposure to dichlorodiphenyltrichloroethane (DDT) and dichlorodiphenyldichloroethylene (DDE) and neurodevelopment among young Mexican American children. Pediatrics. 2006;118(1):233-241.

14) How V, Hashim Z, Ismail P, Md Said S, Omar D, Bahri Mohd Tamrin S. Exploring cancer development in adulthood: cholinesterase depression and genotoxic effect from chronic exposure to organophosphate pesticides among rural farm children. J Agromedicine. 2014;19(1):35-43.

15) Dhananjayan VR, B. Occupational health risk of farmers exposed to pesticides in agricultural activities. Current Opinion in Environmental Science & Health. 2018;4: 31-37.

16) Pouchieu C, Piel C, Carles C, et al. Pesticide use in agriculture and Parkinson's disease in the AGRICAN cohort study. Int J Epidemiol. 2018;47(1):299-310.

17) Munoz-Quezada MT, Lucero BA, Iglesias VP, et al. Chronic exposure to organophosphate (OP) pesticides and neuropsychological functioning in farm workers: a review. Int J Occup Environ Health. 2016;22(1):68-79.

18) Kang H, Cha ES, Choi GJ, Lee WJ. Amyotrophic lateral sclerosis and agricultural environments: a systematic review. J Korean Med Sci. 2014;29(12):1610-1617.

19) Starks SE, Gerr F, Kamel F, et al. Neurobehavioral function and organophosphate insecticide use among pesticide applicators in the Agricultural Health Study. Neurotoxicol Teratol. 2012;34(1):168-176.

20) Colosio C, Tiramani M, Brambilla G, Colombi A, Moretto A. Neurobehavioural effects of pesticides with special focus on organophosphorus compounds: which is the real size of the problem? Neurotoxicology. 2009;30(6):1155-1161.

21) Kamel F, Hoppin JA. Association of pesticide exposure with neurologic dysfunction and disease. Environ Health Perspect. 2004;112(9):950-958.

22) Kamel F, Rowland AS, Park LP, et al. Neurobehavioral performance and work experience in Florida farmworkers. Environ Health Perspect. 2003;111(14):1765-1772.

23) Baldi I, Filleul L, Mohammed-Brahim B, et al. Neuropsychologic effects of long-term exposure to pesticides: results from the French Phytoner study. Environ Health Perspect. 2001;109(8):839-844.

24) Stanganelli I, De Felici MB, Mandel VD, et al. The association between pesticide use and cutaneous melanoma: a systematic review and meta-analysis. J Eur Acad Dermatol Venereol. 2019.

25) Kabir A, Zendehdel R, Tayefeh-Rahimian R. Dioxin Exposure in the Manufacture of Pesticide Production as a Risk Factor for Death from Prostate Cancer: A Meta-analysis. Iran J Public Health. 2018;47(2):148-155.

26) Lemarchand C, Tual S, Leveque-Morlais N, et al. Cancer incidence in the AGRICAN cohort study (2005-2011). Cancer Epidemiol. 2017;49:175-185.

27) Boulanger M, Tual S, Lemarchand C, et al. Agricultural exposure and risk of bladder cancer in the AGRIculture and CANcer cohort. Int Arch Occup Environ Health. 2017;90(2):169-178.

28) Lemarchand C, Tual S, Boulanger M, et al. Prostate cancer risk among French farmers in the AGRICAN cohort. Scand J Work Environ Health. 2016;42(2):144-152.

29) Blair A, Zahm SH. Agricultural exposures and cancer. Environ Health Perspect. 1995;103 Suppl 8:205-208.

30) Khan N, Kennedy A, Cotton J, Brumby S. A Pest to Mental Health? Exploring the Link between Exposure to Agrichemicals in Farmers and Mental Health. Int J Environ Res Public Health. 2019;16(8).

31) Fontana L, Lee SJ, Capitanelli I, et al. Chronic Obstructive Pulmonary Disease in Farmers: A Systematic Review. J Occup Environ Med. 2017;59(8):775-788.

32) Mamane A, Baldi I, Tessier JF, Raherison C, Bouvier G. Occupational exposure to pesticides and respiratory health. Eur Respir Rev. 2015;24(136):306-319.

33) Sekhotha MM, Monyeki KD, Sibuyi ME. Exposure to Agrochemicals and Cardiovascular Disease: A Review. Int J Environ Res Public Health. 2016;13(2):229.

34) Runkle J, Flocks J, Economos J, Dunlop AL. A systematic review of Mancozeb as a reproductive and developmental hazard. Environ Int. 2017;99:29-42.

35) Nagami H, Suenaga T, Nakazaki M. Pesticide exposure and subjective symptoms of cut-flower farmers. J Rural Med. 2017;12(1):7-11.

36) Goldman L, Eskenazi B, Bradman A, Jewell NP. Risk behaviors for pesticide exposure among pregnant women living in farmworker households in Salinas, California. Am J Ind Med. 2004;45(6):491-499.

37) Patz JA, McGeehin MA, Bernard SM, et al. The potential health impacts of climate variability and change for the United States: executive summary of the report of the health sector of the U.S. National Assessment. Environ Health Perspect. 2000;108(4):367-376.

38) Pathak TM, ML; Dahlberg, JA; Kearns, F; Bali, KM; Zaccaria, D. Climate Change Trends and Impacts on California Agriculture: A Detailed Review. Agronomy 2018;8(25).

39) Zhang Y, Beggs PJ, Bambrick H, et al. The MJA-Lancet Countdown on health and climate change: Australian policy inaction threatens lives. Med J Aust. 2018;209(11):474.

40) Watts N, Amann M, Arnell N, et al. The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. Lancet. 2018;392(10163):2479-2514.

41) Watts N, Amann M, Ayeb-Karlsson S, et al. The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. Lancet. 2018;391(10120):581-630.

42) Watts N, Adger WN, Ayeb-Karlsson S, et al. The Lancet Countdown: tracking progress on health and climate change. Lancet. 2017;389(10074):1151-1164.

43) The L. The perfect storm: climate change and its health consequences. Lancet. 2016;387(10026):1348.

44) Watts N, Adger WN, Agnolucci P, et al. Health and climate change: policy responses to protect public health. Lancet. 2015;386(10006):1861-1914.

45) Salas R. Climate Change and Emergency Medicine: A Specialty on the Frontline. 2018; https://www.aliem.com/climate-change-emergency-medicine/. Accessed January 15, 2020.

46) Ziegler C, Morelli V, Fawibe O. Climate Change and Underserved Communities. Prim Care. 2017;44(1):171-184.

47) Takahashi B, Burnham M, Terracina-Hartman C, Sopchak AR, Selfa T. Climate Change Perceptions of NY State Farmers: The Role of Risk Perceptions and Adaptive Capacity. Environ Manage. 2016;58(6):946-957.

48) Arbuckle JG, Jr., Morton LW, Hobbs J. Understanding Farmer Perspectives on Climate Change Adaptation and Mitigation: The Roles of Trust in Sources of Climate Information, Climate Change Beliefs, and Perceived Risk. Environ Behav. 2015;47(2):205-234.

49) Health; NCfF. Algricultural worker occupational health & safety. Occupational Health & Safety Factsheet 2017; http://www.ncfh.org/uploads/3/8/6/8/38685499/fs-occ_health.pdf. Accessed January 15, 2020.

50) Mobed K, Gold EB, Schenker MB. Occupational health problems among migrant and seasonal farm workers. West J Med. 1992;157(3):367-373.

51) Runkle J, Flocks J, Economos J, Tovar-Aguilar JA, McCauley L. Occupational risks and pregnancy and infant health outcomes in Florida farmworkers. Int J Environ Res Public Health. 2014;11(8):7820-7840.

52) Bethel JW, Walsh J, Schenker MB. Preterm, low-birth-weight deliveries, and farmwork among Latinas in California. J Occup Environ Med. 2011;53(12):1466-1471.

53) Zhu JL, Hjollund NH, Andersen AM, Olsen J. Occupational exposure to pesticides and pregnancy outcomes in gardeners and farmers: a study within the Danish National Birth Cohort. J Occup Environ Med. 2006;48(4):347-352.

54) Bretveld RW, Hooiveld M, Zielhuis GA, Pellegrino A, van Rooij IA, Roeleveld N. Reproductive disorders among male and female greenhouse workers. Reprod Toxicol. 2008;25(1):107-114.

55) Bretveld R, Zielhuis GA, Roeleveld N. Time to pregnancy among female greenhouse workers. Scand J Work Environ Health. 2006;32(5):359-367.

56) Lauria L, Settimi L, Spinelli A, Figa-Talamanca I. Exposure to pesticides and time to pregnancy among female greenhouse workers. Reprod Toxicol. 2006;22(3):425-430.

57) Petrelli G, Figa-Talamanca I. Reduction in fertility in male greenhouse workers exposed to pesticides. Eur J Epidemiol. 2001;17(7):675-677.

58) Ahmed P, Jaakkola JJ. Maternal occupation and adverse pregnancy outcomes: a Finnish population-based study. Occup Med (Lond). 2007;57(6):417-423.

59) Chia SE, Shi LM. Review of recent epidemiological studies on paternal occupations and birth defects. Occup Environ Med. 2002;59(3):149-155.

60) Shaw GM, Wasserman CR, O'Malley CD, Nelson V, Jackson RJ. Maternal pesticide exposure from multiple sources and selected congenital anomalies. Epidemiology. 1999;10(1):60-66.

61) Calvert GM, Alarcon WA, Chelminski A, et al. Case report: three farmworkers who gave birth to infants with birth defects closely grouped in time and place-Florida and North Carolina, 2004-2005. Environ Health Perspect. 2007;115(5):787-791.

62) Garry VF, Harkins ME, Erickson LL, Long-Simpson LK, Holland SE, Burroughs BL. Birth defects, season of conception, and sex of children born to pesticide applicators living in the Red River Valley of Minnesota, USA. Environ Health Perspect. 2002;110 Suppl 3:441-449.

63) Weselak M, Arbuckle TE, Wigle DT, Walker MC, Krewski D. Pre- and post-conception pesticide exposure and the risk of birth defects in an Ontario farm population. Reprod Toxicol. 2008;25(4):472-480.

64) Engel LS, O'Meara ES, Schwartz SM. Maternal occupation in agriculture and risk of limb defects in Washington State, 1980-1993. Scand J Work Environ Health. 2000;26(3):193-198.

65) Garcia-Rodriguez J, Garcia-Martin M, Nogueras-Ocana M, et al. Exposure to pesticides and cryptorchidism: geographical evidence of a possible association. Environ Health Perspect. 1996;104(10):1090-1095.

66) Blatter BM, Roeleveld N, Bermejo E, Martinez-Frias ML, Siffel C, Czeizel AE. Spina bifida and parental occupation: results from three malformation monitoring programs in Europe. Eur J Epidemiol. 2000;16(4):343-351.

67) Bell EM, Hertz-Picciotto I, Beaumont JJ. A case-control study of pesticides and fetal death due to congenital anomalies. Epidemiology. 2001;12(2):148-156.

68) Bell EM, Hertz-Picciotto I, Beaumont JJ. Pesticides and fetal death due to congenital anomalies: implications of an erratum. Epidemiology. 2001;12(5):595-596.

69) Flocks J, Kelley M, Economos J, McCauley L. Female farmworkers' perceptions of pesticide exposure and pregnancy health. J Immigr Minor Health. 2012;14(4):626-632.

70) Flocks J, Vi Thien Mac V, Runkle J, Tovar-Aguilar JA, Economos J, McCauley LA. Female farmworkers' perceptions of heat-related illness and pregnancy health. J Agromedicine. 2013;18(4):350-358.

71) Kelley MA, Flocks JD, Economos J, McCauley LA. Female farmworkers' health during pregnancy: health care providers' perspectives. Workplace Health Saf. 2013;61(7):308-313.

72)Arnott C, Patel S, Hyett J, Jennings G, Woodward M, Celermajer DS. Women and Cardiovascular Disease: Pregnancy, the Forgotten Risk Factor. Heart Lung Circ. 2019.

73) Umesawa M, Kobashi G. Epidemiology of hypertensive disorders in pregnancy: prevalence, risk factors, predictors and prognosis. Hypertens Res. 2017;40(3):213-220.

74) Zhu Y, Zhang C. Prevalence of Gestational Diabetes and Risk of Progression to Type 2 Diabetes: a Global Perspective. Curr Diab Rep. 2016;16(1):7.

75) Law A, McCoy M, Lynen R, et al. The prevalence of complications and healthcare costs during pregnancy. J Med Econ. 2015;18(7):533-541.

76)Kelly W, Massoumi A, Lazarus A. Asthma in pregnancy: Physiology, diagnosis, and management. Postgrad Med. 2015;127(4):349-358.

77) Glascoe V., Alysse, C., Schartz, N.A. (2019). Bad Lungs/Bad air: Childhood Asthma and Ecosyndemics among Mexican Immigrant Farmworkers of California's San Joaquin Valley. Human Organization, 78(2), 110-121.

78) Bischoff W.E., Weir M., Summers P., Chen H., Qaundt S.A., Liebman A.K., Arcury T.A. (2012). The Quality of Drinking Water in North Carolina Farmworkers Camps. American Journal of Public Health, 102 (10), 49-54.

79) VanDerslice, J. (2011). Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations. American Journal of Public Health, 101 (S1), 109-114.