

Agricultural Pesticides: Children's Health in Jeopardy – A Review

**Abigail Gbemisola Adeyonu^{1, *}, Oghenerobor Benjamin Akpor²,
Olarewaju Michael Oluba³, Ayoola John Soyombo¹,
Olayinka Olubunmi Alabi¹, Anne Alayemola⁴**

¹Department of Agriculture, Landmark University, Omu-Aran, Nigeria

²Department of Microbiology, Landmark University, Omu-Aran, Nigeria

³Department of Biochemistry, Landmark University, Omu-Aran, Nigeria

⁴Directorate of University Wide Courses, Landmark University, Omu-Aran, Nigeria

Abstract

With increase in world population and industrialization coupled with the negative impacts of climate change, the use of agricultural pesticides has increased greatly. The extensive usage of pesticides in farming and residential areas has exposed millions of adults and children all over the world to the detrimental influence of the toxic chemicals. This has resulted into some devastating health challenges lasting the whole of a lifetime of the victims. Children are at a higher risk of exposure than adults. This is due to the fact that the majority of the pesticides usage globally is on fruits and veggies, hence, children are at risk of low-rate but continuous pesticide exposure. This study was therefore aimed at reviewing of the precarious impact of agricultural pesticides on the health of children. The reviews showed that neonatal exposure to agricultural pesticides is responsible for birth defects, cognitive deficits and childhood cancer in children. Also, postnatal exposure to agricultural pesticides has been implicated in children's respiratory and nervous system diseases. The effect is more on the nervous system. Agricultural pesticides have also been linked to different types of cancer in children. Promotion of integrated farming will be a policy option in other to protect children from hazardous effects of agricultural pesticides.

Keywords

Agriculture, Pesticides, Health, Body Systems

Received: March 30, 2019 / Accepted: May 16, 2019 / Published online: May 28, 2019

@ 2019 The Authors. Published by American Institute of Science. This Open Access article is under the CC BY license.

<http://creativecommons.org/licenses/by/4.0/>

1. Introduction

The demand for agriculture is expected to increase by 50% as a result of the forecasted world population of about 10 billion in 2050 [1]. Globally, agricultural production is under the dangerous influence of climate change, and with increase in the demand for food, the use of agricultural pesticides has increased greatly. The ever increasing demand for food globally has worsened the situation in recent times. This has resulted into intensive use of agricultural pesticides in small

and large scale production of food crops meant for both local consumption and export. The crops that are transported over a long distance are preserved with pesticides for prolonged storage and extension of shelf-life. Agricultural pesticides are chemicals used to increase agricultural productivity. The massive damage caused by pests to agricultural fields and crops makes agriculture to be the largest user of pesticides globally. However, the increase in the usage of agricultural pesticides remains a major concern to the international community because of the associated environmental and health risks.

* Corresponding author

E-mail address: adeyonu.abigail@lmu.edu.ng (A. G. Adeyonu)

According to the International Labour Organization, 31% of the world 3.5 billion employment were engaged in agricultural sector in 2013 [2]. The report also noted that about 60% of the 68 million children engaged in dangerous occupation are in the agricultural sector, with majority of them in developing countries. The high poverty rate in many agrarian countries has been implicated in the high incidence of child labour (71%) in the agricultural sector in 2016. The poverty situation resulted into exposure of about 108 million boys and girls in the world to poor working conditions in agriculture of which close contact with pesticides was not left out [3].

Evidences have shown that children living at close proximity to pesticide-treated agricultural area are at risk of the harmful effects of pesticides [4-6]. Also, the rate of exposure to pesticides is higher among children of farmers than children of non- farmers living in the same rural communities [7]. Children may be exposed to agricultural pesticides through their active involvement in its spraying on farm land or through direct contact with pesticide-treated field [8-10]. Farmers' children are in double jeopardy as they may be vulnerable when they use pesticides to control harmful pests in their place of abodes. They can be exposed during loading, off-loading, mixing and storing of agricultural pesticides. Their exposure may be *in utero* when their mothers are involved in spraying of farm land or place of abode or any other direct contact with pesticides. Children often play in pesticide-treated fields or stay with their parents when pesticides is being applied. Farm workers may track soil and dust that have been contaminated with pesticides into their vehicles and dwellings from where children can contact pesticides. The process of washing farmers' contaminated clothing may spread the residues to the children's clothes [8-10]. Children may also eat food ignorantly from recently pesticide-sprayed fields [11]. This paper was aimed at reviewing the health impacts of agricultural pesticides, with emphasis on children's health.

2. Agricultural Pesticides and Children Exposure

As a result of the extensive usage of pesticides in farming, food, gardens, residential areas, schools, offices etc, millions of adults and children all over the world are exposed to the detrimental influence of the toxic chemicals resulting into some devastating health challenges lasting the whole of a lifetime of the victims. It is indicated that the health impacts of agricultural pesticides depend on the degree and duration of exposure and the chemical composition of the pesticide with potential risks ranging from cancer and complications with nervous and hormonal systems [12]. Sadly, the most

susceptible of the victims are the children. Children in rural areas and expectant mothers spraying pesticides or living near farms are worst hit. Children are at a higher risk of exposure than adults for several reasons. First, children respire more; consume more food and drink more water per unit of body weight than adults, which results into their larger exposure in a pesticide-poisoned surroundings. Second, extremely processed baby foods and chemically processed can-fruits can serve as a source of pesticide residues from fresh produce. Researchers have reported low rates of pesticide residues in manufactured baby foods. Third, the majority of the pesticides usage globally is on fruits and veggies, hence, children are at risk of low-rate but continuous pesticide exposure.

It has been established that children's organs are not completely developed until when they grow older, and because of the continual critical developmental changes, undesirable exposures to agricultural pesticides especially *in utero* can lead to permanent damage later in life [13]. Early life exposure of children to agricultural pesticides can result into damaging of nervous and other systems of the body with negative impact on mental and physiological growth. This may be in form of life long diseases and disorders, such as birth defects, neurological problems, respiratory diseases and cancers [14-15, 13, 16-17]. Some of the disorders may show up only in adulthood, while others, such as cancers may be intergenerationally transmitted. It is reported that it is not just the affected individuals that bear the burden of the hazardous effect of agricultural pesticides but the society as a whole may be endangered. The increasing health burden and its attendant costs on the society may be enormous [18]. The impacts may be decrease in intelligent quotient, as well as rise in behavioural and socialization challenges. During the process of growth and development in children, minute levels of pesticide can truncate the process, thus leading to derail several health impacts [19-20]. Apart from being more susceptible than adults, children behavior such as playing and ignorance of risks predisposes them to more exposure [20].

In a study that examined the vulnerability of rural children to pesticide exposure in four agricultural states, it was reported that rural children were vulnerable to agricultural pesticides [20]. The key recommendations were reduction in the overall use of pesticides and prioritization of actions on pesticides that are harmful to children. Similarly, the World Health Organisation (WHO), recommended the following as measures to reduce the harmful effect of agricultural pesticides on children: reduction and elimination of likely sources of pesticide exposures to children at home and at work; keeping and storing of pesticides from the reach of children; reduction of pesticide usage through incorporation of integrated pest management; training of health care

providers on efficient ways to recognize and manage pesticide poisoning; provision of adequate training for people on judicious use and prevention of pesticide exposure; running of information and educative programs and reduction of risk through comprehensive life-cycle approach [21].

3. Hazardous Impacts of Agricultural Pesticides on Children

Pre-natal exposures, also known as exposures to an unborn offspring can occur as a result of a mother's exposure while pregnant or from a father's job exposure before the fertilization of an egg by a sperm. Pre-natal exposure to an organophosphate insecticide (chlorpyrifos) is associated with neurobehavioral shortfall in humans and animal models [22]. In a study on the association between pre-natal exposure to agricultural pesticides and attention-related outcomes among children living in agricultural area, it was revealed that pre-natal exposure to agricultural pesticides impacted negatively on children's attention as indicated by mothers' reports and psychometrician observation as well as direct examination [23].

A related study to determine the effect of chlorpyrifos exposure on the structure of the brain of 40 children within the ages of 5.9 years -11.2 years reported that there was no significant difference between the influence of pre-natal exposure to pesticides on brain development of boys and girls. However, a significant relationship occurred between the pre-natal exposure to pesticides and structure of human brain [24]. There is increase in rate of birth defects, development disabilities and attention deficit disorder. Leukemia and brain tumors among children in rural areas is on the increase and yet, no provision has been made for their protection [25]. A study on relationship between exposure to organophosphate pesticides before and after birth and the cognitive abilities in school-age children, showed no direct correlation between pre-natal exposure to organophosphate and intellectual development in children who were 7 years old [26]. A similar study however established a direct association between pre-natal exposure to pesticides and brain tremor in middle childhood [27]. It is deduced that a positive correlation exists between gestational exposure to agricultural pesticides and children's neurological development [28]. The findings of the study on the association between children's neuropsychological development and pre-natal exposures to pesticides in agricultural communities showed that pre-natal exposure to agricultural pesticides was implicated in low intelligence quotient and verbal comprehension domain. The influence was stronger on boys than girls [29]. It is opined that early

life exposure to agricultural pesticides and childhood asthma are positively correlated [30-31].

The human brain is the controlling center of the nervous system which controls all the physical and cognitive human activities, hence, any harm to the brain and the nervous system as a whole may result in a lasting undesirable outcome for the physical, psychological or social well-being of an individual. The biological process of brain development could be impaired most especially during the critical window time due to exposure to toxic chemicals including agricultural pesticides [32]. A study was conducted on the impact of Organophosphate Pesticide (OP) exposure on Hispanic children's cognitive and behavioral functioning. According to the study, all children had a detectable level of at least one OP pesticide metabolite. Children's exposure to OP had indirect significant correlation with speed of attention, mental and conceptual flexibility [33].

A research was conducted on the relationship between post-natal exposures to agricultural pesticides and brain development of children living in rural area. It was reported that post-natal exposure to agricultural pesticides had negative influence on children's neuropsychological development [29]. In a similar study on the influence of exposure to pesticides on children's neurodevelopment, exposure to pesticides was indicated to have negative influence on children's neurodevelopment, with the influence greater in females than males [34]. A study on the association between risk of childhood cancers and residence in agriculturally intense areas in the United State, opined that that living in an area with high intensity of agricultural activities could predispose children in the area to childhood cancer and that the risk for different cancers varies with the types of crops [35]. A study was conducted on epidemiological characteristics of acute pesticide poisoning in children. The results showed that death rate among the subjects was about 2.24%. The result further indicated that pesticide poisoning was higher among females than males, with higher mortality rate among pre-school children than adolescent with majority of the poisoning occurring in rural areas [36].

4. Conclusion

Agriculture provides food for the populace. The demand for food is expected to increase with increase in world population. Globally, agricultural production is under the risky influence of climate change, and with increase in the demand for food, the use of agricultural pesticides has increased greatly. This has resulted into rigorous use of agricultural pesticides in farming. The extensive usage of the

chemical remains a major concern to the international community because of the associated impact on the health of adults and children. Children are at a higher risk than adults. This study reviewed the dangerous impact of agricultural chemicals on children's health. Some of the hazardous effects are birth defects, cognitive deficits in children, asthma, lung infection, brain infection and childhood cancer. The review recommends promotion of integrated farming in other to protect the health of the children.

References

- [1] Food and Agriculture Organization of the United Nations (FAO). The Future of Food and Agriculture: Trends and challenges, FAO, Rome 2017. Available online: www.fao.org/publications/fofa/en. (accessed on 26 December, 2018).
- [2] International Labour Organization (ILO). Agriculture; Plantations; Other Rural Sectors, ILO, Geneva 2014. Available online: www.ilo.org/global/industries-and-sectors/agriculture-plantations-other-rural-sectors/lang-en/index.htm. (accessed on 26 December, 2018).
- [3] International Labour Office 2017. Global Estimates of Child Labour: Results and trends, 2012–2016, International Labour Organization, Geneva 2017. Available online: www.ilo.org/global/topics/child-labour/lang-en/index.htm. (accessed on 30 December, 2018).
- [4] Lu, C.; Fenske, R. A.; Simcox, N. J.; Kalman, D. Pesticide exposure of children in an agricultural community: evidence of household proximity to farmland and take home exposure pathways. *Environ Res* 2000, 84, 290-302.
- [5] Curl, C. L.; Fenske, R. A.; Kissel, J. C.; Shirai, J. H.; Moate, T. F. et al. Evaluation of take-home organophosphorus pesticide exposure among agricultural workers and their children. *Environ Health Perspect* 2002, 110, A787-A792.
- [6] Harnly, M. E.; Bradman, A.; Nishioka, M.; Mckone, T. E. Smith, D.; et al. Pesticides in dust from homes in an agricultural area. *Environ Sci Technol.* 2009, 43, 8767-8774.
- [7] Hylanda, C.; Laribib, O. Review of take-home pesticide exposure pathway in children living in agricultural areas. *Environmental Research* 2017, 156, 559–570.
- [8] Quandt, S. A., Arcury, T. A.; Rao, P. Snively, B. M.; Camann, D. E.; et al. Agricultural and residential pesticides in wipe samples from farmworker family residences in North Carolina and Virginia. *Environ Health Perspect.* 2004, 112, 382-387.
- [9] Arcury, T. A.; Quandt, S. A. (Eds). *Latino farmworkers in the Eastern United States: health, safety and justice*. New York: Springer 2009, x, 240 p. 13.
- [10] Bradman, A.; Whitaker, D.; Quirós, L.; Castorina, R. B.; Claus H.; et al. Pesticides and their metabolites in the homes and urine of farmworker children living in the Salinas Valley, CA. *J Expo Sci Environ Epidemiol* 2007, 17, 331-349.
- [11] Beamer, P. I.; Canales, R. A.; Ferguson, A. C.; Leckie, J. O.; Bradman, A. Relative pesticide and exposure route contribution to aggregate and cumulative dose in young farmworker children. *Int J Environ Res Public Health* 2012, 9, 73-96.
- [12] Healthline Media. Worried about pesticide exposure? here's what you need to know 2019.. Available online: <https://www.healthline.com/health-news/pesticide-exposure-heres-what-you-need-to-know#7> (Accessed 27/03/2019).
- [13] Chalupka, S.; Chalupka, A. N. The impact of environmental and occupational exposures on reproductive health. *Journal of Obstetric, Gynecologic, and Neonatal Nursing* 2010, 39; 84-100.
- [14] International Programme on Chemical Safety (IPCS). INCHEM: Chemical safety information from intergovernmental organizations. Geneva 20101, World Health Organization, International Programme on Chemical Safety.
- [15] Gilden, R. C., Huffling, K.; Sattler, B. Pesticides and health risks. *Journal of Obstetric, Gynecologic, and Neonatal Nursing* 2010, 39, 103-110.
- [16] Hu, R.; Huang, X.; Huang, J.; Li, Y.; Zhang, C, Yin, Y.; et al. Long- and Short-Term Health Effects of Pesticide Exposure: A Cohort Study from China. *PLoS One* 2015, 10, 1-13.
- [17] Kim, K. H.; Kabir, E.; Jahan, S. A. Exposure to pesticides and the associated human health effects. *Science of The Total Environment* 2017, 575, 525–535.
- [18] UNICEF. 2018. Understanding the Impacts of Pesticides on Children: A discussion paper. United Nations Children's Fund (UNICEF).
- [19] Beamer, P. I. Pesticide Exposure of Farmworkers' Children, Pesticides in the Modern World - Effects of Pesticides Exposure, Dr. Margarita Stoytcheva (Ed.), ISBN: 978-953-307-454-2, InTech 2011, Available online: <http://www.intechopen.com/books/pesticides-in-the-modern-world-effects-of-pesticidesexposure/>. (Accessed 27/01/2019).
- [20] Pesticide Action Network North America. Kids on the frontline 2016. Available online: <https://www.panna.org/sites/default/files/KOF-exsummary-english.pdf> (accessed 27/03/2019).
- [21] WHO. Children are facing high risk from pesticide poisoning. Available at: <https://www.who.int/mediacentre/news/notes/2004/np19/en/> (accessed 27/03/2019).
- [22] Winchester, P. D.; Huskins, J.; Ying, J. Agrichemicals in surface water and birth defects in the United States. *Acta Paediatr* 2009, 98, 664-669.
- [23] Marks, A. R.; Harley, K.; Bradman, A.; Kogut, K.; Barr, D. B.; et al. Organophosphate pesticides exposure and attention in young Mexican-American children: the CHAMACOS study. *Environ Health Perspect* 2010, 118, 1768-1774.
- [24] Rauh, V.; Arunajadai, S.; Horton, M.; Perera, F.; Hoepner, L.; et al. Seven-year neurodevelopmental scores and prenatal exposure to chlorpyrifos, a common agricultural pesticide. *Environ Health Perspect.* 2011, 119, 1196-1201.
- [25] Grossman, E. Children in Farm Communities Pay Steep Price for the Food We Eat. Available online: <https://civileats.com/2016/05/10/> (accessed 27/03/2019).
- [26] Bouchard, M. F.; Chevrier, J.; Harley, K. G. Prenatal exposure to organophosphate pesticides and IQ in 7-year-old children. *Environ. Health Perspect.* 2011, 119; 1189-1195.

- [27] Rauh, V. A.; Garcia, W. E.; Whyatt, R. M.; Horton, M. K.; Barr, D. B.; et al. Prenatal exposure to the organophosphate pesticide chlorpyrifos and childhood tremor. *Neurotoxicology* 2015, 51; 80-86.
- [28] Shelton, J. F.; Geraghty, E. M.; Tancredi, D. J.; Delwiche, L. D.; Schmidst, R. J.; et al. Neurodevelopmental disorders and prenatal residential proximity to agricultural pesticides: the CHARGE study. *Environ Health Perspect* 2014, 122, 1103-1109.
- [29] González-Alzaga, B.; Hernández, A. F.; Rodríguez-Barranco, M.; Gomez, M. O.; Aquilar-Garduño, M.; et al. Pre- and postnatal exposures to pesticides and neurodevelopmental effects in children living in agricultural communities from South-Eastern Spain. *Environment International* 2015, 85; 229-237.
- [30] Raanan, R.; Harley, K. G.; Balmes, J. R.; Brandman, A.; M. Lipsett, M.; et al. Early-life exposure to organophosphate pesticides and pediatric respiratory symptoms in the CHAMACOS cohort. *Environ Health Perspect* 2015, 123: 179-85.
- [31] Suhartono, S.; Kartini, A; Subagio, H. W.; Budiyo, Utari, A.; Suratman, S.; Sakundarno, M. Pesticide Exposure and Thyroid Function in Elementary School Children Living in an Agricultural Area, Brebes District, Indonesia. *The International Journal of Occupational and Environmental Medicine* 2018, 9, 3.
- [32] Roberts, J. R.; Dawley, D. H.; Reigart, J. R. Children's low-level pesticide exposure and associations with autism and ADHD: a review. *Pediatric Research* 2019, 85, 234-241.
- [33] Lizardi, P. S.; O'Rourke, M. K.; Morris, R. J. The Effects of Organophosphate Pesticide Exposure on Hispanic Children's Cognitive and Behavioral Functioning. *Journal of Pediatric Psychology* 2008, 33, 91-101.
- [34] van Wendel de Joode, B.; Mora, A. M.; Lindh, C. H.; Hernández-Bonilla, D.; Córdoba, L.; et al. Pesticide exposure and neurodevelopment in children aged 6-9 years from Talamanca, Costa Rica. *Cortex* 2016, 85, 137-150.
- [35] Carozza, S. E.; Li, B.; Elgethun, K.; Whitworth, R. Risk of childhood cancers associated with residence in agriculturally intense areas in the United States. *Environ Health Perspect* 2009, 116, 559-565.
- [36] Yimaer, A.; Chen, G.; Zhang, M.; Zhou, L.; Fang, X.; et al. Childhood pesticide poisoning in Zhejiang, China: a retrospective analysis from 2006 to 2015. *BMC Public Health* 2017, 17, 602.