

# Systematic Review: The Effect Of Lead In The Body On The Occurrence Of Stunting

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## Abstract

**Aims:** The purpose of writing this literature review is to determine the effect of lead on the possibility of stunting. **Methods:** The inclusion criteria used are 1) community population of human. 2) without intervention 3) without comparison 4) Outcome: stunting factor, lead effect on stunting, stunting becomes unsteady. 5) Clinical Trials. 6) articles published between 2017 and 2022 and 7) English. While the exclusion criteria used are 1) Abstract, 2) Free Access, and 3) Full Text. Data sources are from Google Scholar and PubMed. Literature review writing starts from May to July 2022. **Results:** Based on a literature review conducted on 4 articles, it was found that there was an effect of lead in the blood on the likelihood of stunting. **Conclusions:** There is a relationship between lead and stunting. However, lead is not the only cause of stunting. The incidence of stunting globally is more often influenced by the low level of community income. The results of this literature review are important to assist the government in controlling exposure to lead (Pb) chemicals in the work environment

**Key words :** Lead, Stunting, Secure work, Pb

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## INTRODUCTION

Lead is a bluish silver heavy metal with a low melting point and is usually found in nature in combination with other elements and has a small amount of toxic properties (ATSDR, 2019). The symbol of lead is Pb derived from the Latin word *plumbum*. Lead has atomic number 82 which in the periodic system is located in group IVA and period 6. In general, lead is used as an ingredient in the motor vehicle, battery, fuel, building paint, etc. Based on research done by Gleason, lead naturally exists on earth and continues to grow with the development of the industrial world. Lead-contaminated particles can be transported through soil, water, and air (ATSDR, 2019). Based on several studies of lead found in water, food ingredients (sweeteners, fruits, marine products, etc.), and toys contribute 20% to their concentration in human blood or the Blood Lead Concentration. In addition, Pb in child blood can occur as a result of transmission from mother to baby through Mother's Milk Air (ASI) (Skakkekek et al., 2011) and transparently during intrauterine life (Chen et al., 2014). One developing country with Pb pollution in its water that has exceeded the maximum pollution threshold set by the

government is Indonesia (AkhsanPanna, Yeni Dhamayanti, 2019). Chen et al at Hisamuddin (2020) stated that adverse respiratory health impact affecting children living in urban area may be influenced by the exposure to air pollutants produced by vehicles emission. Lead Pb that exceeds the safety threshold in the human body can cause a variety of disorders, such as stunting growth (Gleason et al., 2016).

Stunting is a chronic nutritional problem that describes the slowing growth of long-term malnutrition (Amin, 2014). Stunting usually occurs during the period of 1,000 Days of Life (HPK) divided into 270 days during pregnancy and 730 days after the baby is born. This has been scientifically proven to be a defining period of life. This is supported by the WHO's Child Growth Standard's statement that the child's process is short or stunting usually begins from the beginning of the 2 to 3 year old's life and lasts until the child turns 18. In general, the causes of stunting are malnutrition, lack of micro nutrients, and infection. However, there are further studies on the contribution of toxic

environmental exposure including lead in it. Lead exposure is thought to cause nutritional deficits and ultimately disrupt nerve development in children.

Based on this description, the author is interested in creating a review literature aimed at studying lead, stunting, and what impact lead has on the probability of stunting both on fetal development and after birth.

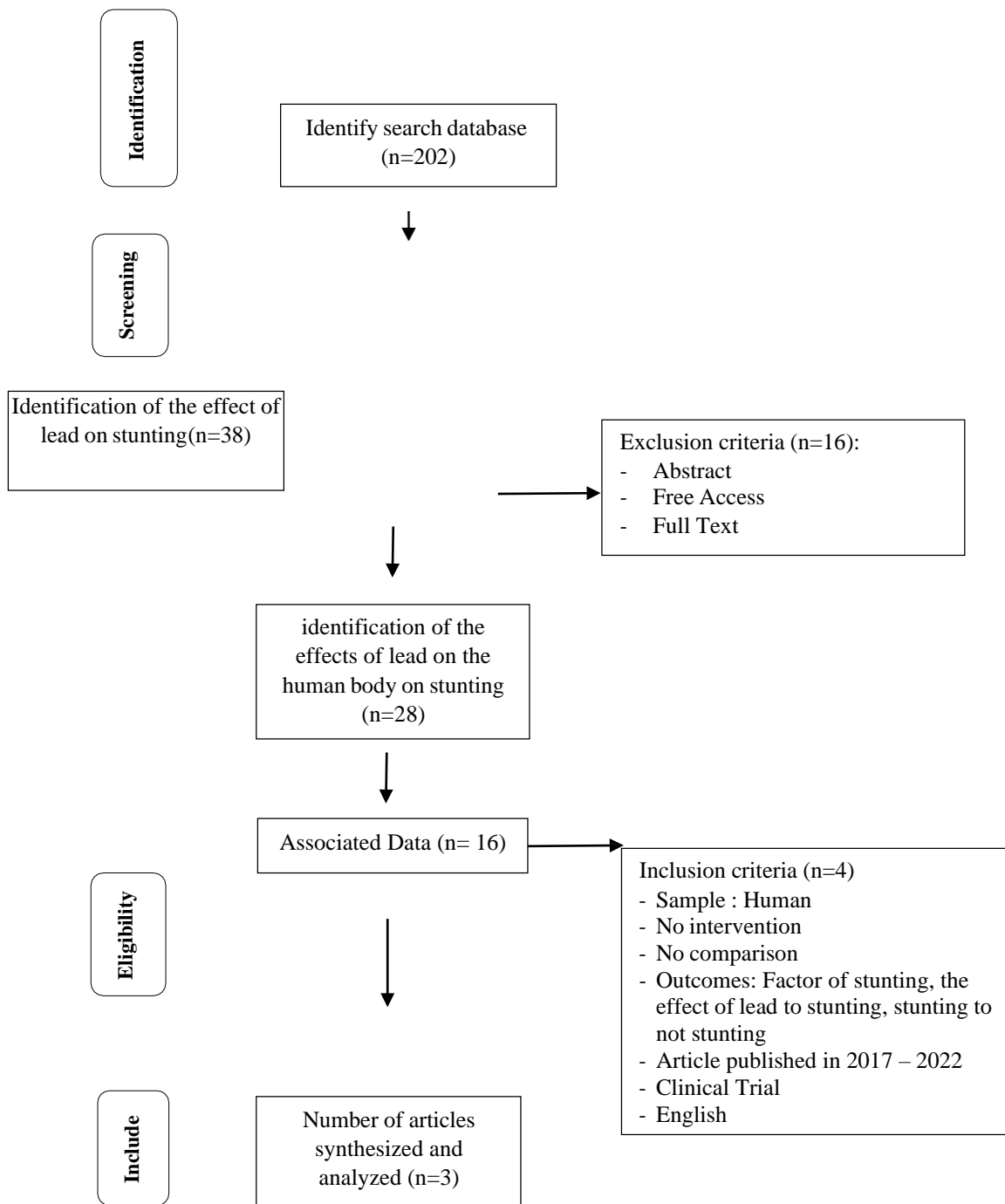
## **METHODS**

Systematic review reference source articles are sourced from PubMed and Google Scholar. Data search using Boolean search methods uses the keywords "Effect" and "Lead" and "Stunting". The preferred reporting item for Systematic Review and Meta-Analysis Protocol (PRISMA-P) is used to write this systematic review. All references are written in English with specific publication years from 2017 to 2022. References in each article found during the initial search are also investigated, and articles or journals

relevant to the topic will be identified and reviewed in this writing.

## **RESULTS**

Using PubMed or Google Scholar search methods, research related to the title Stunting and lead: using causal mediation analysis to better understand how environmental lead exposure affects cognitive outcomes in children, PROCOMID, a Food-Assisted Maternal and Child Health and Nutrition Program, Contributes to Postpartum Weight Retention in Guatemala: A Cluster-Randomized Controlled Intervention Trial, Independent and combined effects of improved water, sanitation, and hygiene, and improved complementary feeding, on stunting and anaemia among HIV-exposed children in rural Zimbabwe: a cluster-randomised controlled trial, dan Protocol for the trial to establish a causal linkage between mycotoxin exposure and child stunting: a cluster randomized trial. Below is a diagram of Prism's plot of data search by PICOS method and its explanation.



**Image 1.** Diagram of the process of searching for data on the effect of lead to stunting in both onfetal development and after birth.

The total lead and stunting data(n=202) is then focused on the impact of lead on stunting (n=38), leadinvolvement in the human body on stunting (n=28), and then on the research article type (n=16). Subsequent to 16 types of research articles, the choice of articles analyzed based on PICOS inclusion criteria (Population, Intervention, Comparison, Results, Study Design, Year of Publication, and Language) was as

follows: 1) community population. 2) without intervention 3)

without comparison 4) Outcome: factor stunting, lead effect on stunting, stunting becomes unsteady.

5) Clinical Trial. 6) articles published between 2017 and 2022 and 7) English.

Each article is studied and analyzed according to inclusion criteria. There are many articles that are eliminated because they do not meet the criteria: there are interventions, not research articles, in the results section that do not present

the set variability and the research year is not a time span between 2017 and 2022. An analysis of articles is obtained after the identification, screening, criteria determination of up to 4 articles are analyzed.

A total of four international articles meet the criteria and are sampled for synthesis and analysis. The inclusion criteria for "results" are determined according to the purpose

of the library review, variability is included in the PICOS method to be extensively explored, and clearly the factors causing the stunting, lead effect on the stunting, and getting the stunting to be unstunting.

There are 4 articles that meet the criteria, which are then analyzed and synthesized and shown in table 1 below:

**Table Of The Effect Of Lead In The Body On The Occurrence Of Stunting**

No	Title	Design, Samples, Measurements	Analysis Teqnique	Result
1.	Stunting and lead: using causal mediation analysis to better understand how environmental lead exposure affects cognitive outcomes in children	Participants were 734 children from a longitudinal birth cohort established in rural Bangladesh to study the health effects of prenatal and early childhood environmental metal exposures. Lead exposure was estimated using umbilical cord blood samples obtained at birth and blood obtained via	This research uses a cohort study and laboratory tests at the Trace Metals Laboratory HSPH uses ICP-MS	Stunting was not a mediator of the effect of lead in our analyses. Results suggested effect modification by stunting. In an area of Bangladesh with lower lead exposures (median umbilical cord blood lead concentration, 1.7 $\mu\text{g}/\text{dL}$ ), stunting modified the relationship between prenatal blood lead concentrations and cognitive score at age 2–3 years. A 1-unit increase in natural log cord blood lead concentration in the presence of stunting was associated with a 2.1-unit decrease in cognitive scores ( $\beta = -2.10$ ,

		<p>venipuncture at age 20–40 months. Stunting was determined using the World Health Organization’s standards. Neurodevelopment was assessed at age 20–40 months years using the Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III).</p>		<p>SE = 0.71, P = 0.003). This interaction was not found in a second study site where lead exposures were higher (median umbilical cord blood lead concentration, 6.1 µg/dL, <math>\beta = -0.45</math>, SE = 0.49, P = 0.360).</p>
2.	<p>PROCOMI D, a Food-Assisted Maternal and Child Health and Nutrition Program, Contributes to Postpartum Weight Retention in Guatemala: A Cluster-Randomized Controlled</p>	<p>This research used linear mixed models controlling for pregnancy weight with random cluster and mother effects. Data on 3535 women were analyzed</p>	<p>All analyses in this research conducted using STATA 14 (StataCorp LP) and pertain to the individual level.</p>	<p>The results of the BMI model show that at 12 mo postpartum, the program had a significant impact on women’s BMI (in kg/m<sup>2</sup>) of 0.34, 0.32, and 0.41 in arms A, D, and E, respectively (Supplemental Figure 1). At 18 mo, the impact was marginally significant in arm A only and at 24 mo no significant effect was found. Using a rigorous study design, our study demonstrates that an FA-MCHN program, aiming to reduce childhood</p>

	Intervention Trial			<p>undernutrition and implemented in an area with a high prevalence of overweight and obesity, increased women's weight in the perinatal period. In the standard program, i.e., the arm receiving the FFR and CSB as the individual ration, the program had an overall estimated effect of nearly 600 g at 24 mo postpartum. The results suggest a positive relation between the size of the family ration and the impact on women's weight. The largest program impact and the largest number of significant effects were found in the standard program. Smaller effects on weight, and at fewer time points, were found with the smaller family rations.</p>
3.	Independent and combined effects of improved water, sanitation, and hygiene, and improved	The Sanitation Hygiene Infant Nutrition Efficacy (SHINE) trial is cluster randomised 2x2 factorial trial in two districts in rural Zimbabwe. Women were eligible for	Regrssion model and Wald Test	<p>Between Nov 22, 2012, and March 27, 2015, 726 HIV-positive pregnant women were included in the trial. 668 children were evaluated at 18 months (147 from 46 standard of care clusters; 147 from 48 IYCF clusters; 184 from 44 WASH clusters; 190 from 47 IYCF plus WASH clusters). Of the 668</p>



	<p>complementary feeding, on stunting and anaemia among HIV-exposed children in rural Zimbabwe: a cluster-randomised controlled trial</p>	<p>inclusion if they permanently lived in the trial clusters (ie, the catchment area of between one and four village health workers employed by the Zimbabwean Ministry of Health and Child Care) and were confirmed pregnant. Clusters were randomly allocated to standard of care (52 clusters); IYCF (20 g small-quantity lipid-based nutrient supplement daily for infants from 6 months to 18 months, complementary feeding counselling with context-specific messages, longitudinal delivery, and reinforcement; 53 clusters); WASH</p>	<p>children, 22 (3%) were HIV-positive, 594 (89%) HIV-exposed uninfected, and 52 (8%) HIV-unknown. The IYCF intervention increased mean length for age Z score by 0.26 (95% CI 0.09–0.43; <math>p=0.003</math>) and haemoglobin concentration by 2.9 g/L (95% CI 0.90–4.90; <math>p=0.005</math>). 165 (50%) of 329 children in the non-IYCF groups were stunted, compared with 136 (40%) of 336 in the IYCF groups (absolute difference 10%, 95% CI 2–17); and the prevalence of anaemia was also lower in the IYCF groups (45 [14%] of 319) than in the non-IYCF groups (24 [7%] of 329; absolute difference 7%, 95% CI 2–12). The WASH intervention had no effect on length or haemoglobin concentration. There were no trial-related adverse or serious adverse events. Since HIV-exposed children are particularly vulnerable to undernutrition and responded well to improved complementary feeding, IYCF interventions could have considerable</p>
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		(ventilated, improved pit latrine, two hand-washing stations, liquid soap, chlorine, play space, and hygiene counselling; 53 clusters); or IYCF plus WASH (53 clusters).		benefits in areas of high antenatal HIV prevalence. However, elementary WASH interventions did not lead to improvements in growth.
4.	Protocol for the trial to establish a causal linkage between mycotoxin exposure and child stunting: a cluster randomized trial	The trial is being conducted in Kongwa District, Dodoma Region of Tanzania. This district was selected because stunting in the region is 37%, slightly above the national average, and there were 8000 live births in 2017, enough to support the trial's sample size [32]. The unit of randomization is a health facility. All 52 health facilities in the district (1 district hospital, 4 health centers and	All outcomes will be presented using descriptive statistics; normally distributed data by the mean and standard deviation (SD) and skewed distributions by the median and interquartile range (IQR)	The results of this study by performing three interventions showed that in the first 17 days of the trial, 66% of babies in the baseline and 71% of babies in the follow-up (n=35) consumed peanuts the previous day. A little more mothers reported the addition of peanuts in porridges and vegetables on follow-up rather than basic, indicating a willingness to incorporate educational messages into baby feeding practices. The second trial tested maternal acceptance of intervention conditions (pre-blended porridge flour provision). Three consecutive days of urine samples were collected at baseline and follow-up in all

		46 dispensaries) were randomized into the control or intervention group.	infants (n = 37). Low AF pre-blended porridge flour supply reduces the prevalence of urine AFM1 detected by 81% after 7-10 days of AF-free food delivery, indicating a high acceptance rate. Based on these findings, we improved our trial intervention to promote and provide pre-blend flour at the ratio of 4 parts corn to 1 part peanut, the median ratio of practice found by mothers in 24 hours collected in mini trials. This decision will reduce the potential difference in food intake between groups and reduce the ethical concerns of increasing peanut consumption in control groups
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## DISCUSSION

Based on literature review results although 10 to 15 g/dL has long been considered to be the lower threshold for lead neurotoxicity (Pb) in children, recent improvements in research design have provided empirical evidence that there may not be a safe level of Pb exposure. Blood metal levels, such as lead in blood,

were not surveyed nationwide; however, some previous studies in (Gleson et al, 2020) found that 78% of children from urban and rural areas had lead levels in blood above the CDC's reference level of 5 g/dL and 87% of children in primary schools in Dhaka had BLL  $\geq$  10 g/dL. In contrast, about 97.5% of children in the U.S. have lead levels below the

current reference level of 5 g/dL. Results from prospective cohort studies have provided evidence that low levels in the uterus of exposure to Pb may interfere with the growth and development of the baby. The central cord blood Pb level below 10 g/dL has been associated with birth weight loss, weight gain and decreased body mass index. In the neonate of the Cleveland study, abnormal reflexes and neurological soft signature scales are related to central Pb levels (M=5.8g/dL) and muscle tonicity scales are related to maternal blood Pb concentrations (M=6.5 g/dL). The results of the Mexico City cohort showed a link between maternal blood Pb levels in mid-term pregnancy (M=7.7 g/dL) and responses raised by brain stem hearing in newborns, 3-month-old infants, and 67-month-old children. The visual function deficit is also seen in the concentration of Pb of the central cord blood as low as 10.5 g/dL. In the Boston cohort where the central cord blood Pb was lower than 16 g/dL for 90% of participants, higher exposure was attributed to a score drop in the Bayley Scale Infant

Development Index at 6, 12, 18 and 24 months.

Based on literature review results, one of the common indicators of nutritional deficits is stunted growth, which occurs when the height (or length) of a child for a certain age is under 5<sup>th</sup> percentile. Current estimates show that the poorest children in the world have more than double the stunting rate of the richest children. Similar trends are seen in the global burden of lead exposure, with children in developing countries at the greatest risk of exposure to these heavy metals. The findings highlight the strong possibility of simultaneous exposure, but from the discovery of only one study investigated the effects and interactions of joint exposure to lead and stunting on neural development; no significant metal-by-metal-gathering interactions for lead, arsenic, and manganese were reported. Thirty-six percent of children under the age of 5 in Bangladesh are stunting, and domestic stunting rates are higher as social economic status declines. At the district administrative level, the stunting rate ranges from 28 to 51%,

and more than half of Bangladesh's districts (39/64) have a stunting rate greater than the World Health Organization's critical threshold of 40%. Additionally, based on research (Andre et al, 2020) Since HIV-adjacent children are particularly susceptible to malnutrition and respond well to better breastfeeding food delivery, PMBA interventions can have considerable benefits in areas with high prevalence of antenatal HIV. However, basic WASH intervention does not lead to increased growth. Meanwhile, studies have revealed that stunting is estimated to contribute to 14-17% of child deaths under the age of 5 and is a risk factor for poor cognitive and motor development and educational outcomes. The study also revealed that exposure to fetal and postnatal aflatoxins is one of the factors that decrease linear growth.

The concentration of lead in the blood exceeding the threshold value can have an effect on the probability of child stunting. According to research (Gleason et al, 2020) during pregnancy, the mother's Pb is transferred through the placenta, putting the developing fetus at risk.

The fetal stage is thus considered to be a period that is particularly susceptible to exposure to Pb even from the lowest exposure levels. Stunting may also act as an effect modifier, i.e., a greater adverse effect of lead on children with stunting. One potential mechanism for this is increased lead absorption: children with poor nutritional status can absorb more metal into their body than children with adequate nutritional intake, leading to a greater decline in neurodevelopment. In addition, lead and malnutrition affect neuron metabolism. This combination can lead to a greater decline in neural development. Nevertheless, studies conducted by Andre and Leroy's research showed no significant results for the application of WASH (water, sanitation, and hygiene) in reducing the probability of stunting.

## CONCLUSION

Based on the above description, the conclusion of the literature review is that there is a relationship between the levels of lead in the blood of the mother and the child in the probability of stunting. Nevertheless, lead is not the only

factor in the high stunting rate in the world. Globally stunting is most common in developing countries and with an inadequate economic background. Inadequate food intake and disease are considered to be the direct causes of malnutrition and stunting. However, improving the baby's diet through breastfeeding food intervention proved to reduce stunting only slightly. There is also a limitation of evidence so research is needed to prove the influence of lead and stunting. Based on the search results, only one study investigated the joint effects and interactions of joint exposure to lead and stunting on neural development; no significant metal-by-metal-gathering interactions for lead, arsenic, and manganese were reported. Additionally, other factors such as lack of sanitation, exposure to aflatoxin, additional diseases such as anemia and HIV in rural areas. This literature review is important to help the government control the exposure of lead chemicals in blood especially to mothers and children under 3 years of age in the working environment.

## REFERENCE

1. Damayanti, D. A. (2011). Evaluasi kandungan logam Berat Pb dan CD dalam Sedimen Air Sungai Bengawan Solo Di Sekitar Kawasan Industri Jurug Surakarta (Doctoral dissertation, UMS).
2. Gleason, K. M., Valeri, L., Shankar, A. H., Obrycki, J. F., Ibne Hasan, M. O. S., Mostofa, G., ... & Mazumdar, M. (2020). Stunting and lead: using causal mediation analysis to better understand how environmental lead exposure affects cognitive outcomes in children. *Journal of Neurodevelopmental Disorders*, 12(1), 1-10.
3. Hisamuddin, N. H., Jalaludin, J., Yusof, A. N., & Tualeka, A. R. (2020). Genotoxic effects of exposure to urban traffic related air pollutants on children in Klang Valley, Malaysia. *Aerosol and Air Quality Research*, 20(12), 2614-2623.
4. Jedrychowski, W., Perera, F. P., Jankowski, J., Mrozek-Budzyn, D., Mroz, E., Flak, E., ... & Lisowska-Miszczuk, I. (2009). Very low prenatal exposure to lead and mental development of children in infancy and early childhood. *Neuroepidemiology*, 32(4), 270-278.
5. LEONI, L., DIARSVITRI, W., & BIUTIFASARI, V. B. (2021). Pengaruh Pencemaran Logam Berat Timbal (Pb) dan Ekskresi Iodium Urine (EIU) Terhadap Kejadian Stunting Pada Anak Usia 25-60 Bulan di Kelurahan Kedung Cowek Surabaya. *Hang Tua Medical Journal*, 18(2), 159-171.
6. Leroy, J. L., Olney, D. K., & Ruel, M. T. (2019). PROCOMIDA, a food assisted maternal and child health and nutrition program, contributes to post partum weight retention in Guatemala: a cluster-randomized

- controlled intervention trial. *The Journal of nutrition*, 149(12), 2219-2227.
7. Phillips, E., Ngure, F., Smith, L. E., Makule, E., Turner, P. C., Nelson, R., ... & Kassim, N. (2020). Protocol for the trial to establish a causal linkage between mycotoxin exposure and child stunting: a cluster randomized trial. *BMC Public Health*, 20(1), 1-11.
  8. Plusquellec, P., Muckle, G., Dewailly, E., Ayotte, P., Jacobson, S. W., & Jacobson, J. L. (2007). The relation of low-level prenatal lead exposure to behavioral indicators of attention in Inuit children in Arctic Quebec. *Neurotoxicology and Teratology*, 29(5), 527-537.
  9. Prendergast, A. J., Chasekwa, B., Evans, C., Mutasa, K., Mbuya, M. N. N., Stoltzfus, R. J., Smith, L. E., Majo, F. D., Tavengwa, N. V., Mutasa, B., Mangwadu, G. T., Chasokela, C. M., Chigumira, A., Moulton, L. H., Ntozini, R., Humphrey, J. H. (2019). Independent and combined effects of improved water, sanitation, and hygiene, and improved complementary feeding, on stunting and anaemia among HIV exposed children in rural Zimbabwe: a cluster-randomised controlled trial. *Lancet Child Adolesc Health*, 3(2):77-90.
  10. Tualeka, A. R., Jalaludin, J., Salesman, F., Wahyu, A., & Daika, N. (2020). Correlation between age, working period and work related musculoskeletal complaints with nordic body map among fishermen. *Iranian Journal of Public Health*, 49(3), 601-602.
  11. Tualeka, A. R., Kalamillah, H., & Meidikayanti, W. (2019). Association between duration working with lung disruption condition using pulmonary vital capacity (PVC) test on lathe worker at Yogyakarta, Indonesia. *Indian Journal of Forensic Medicine & Toxicology*, 13(2), 396-400.
  12. Tualeka, A. R., Rahmawati, P., Russeng, S. S., Susilowati, I. H., & Jalaludin, J. (2020). Factors analysis affecting nurse efficacy in implementing resuscitation in cardiac arrest patients [Análisis de factores que afectan la eficacia de la enfermera en la implementación de la reanimación en pacientes con paro cardíaco]. *Opcion*, 36(Special), 360-375.