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A Multimedia Environmental Model to Predict the Lead Concentration in Children Blood near Al-Dorah Refinery in Baghdad

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ABSTRACT

Lead-contaminated water, soil, and air have been perceived as potential sources of lead exposure for a considerable length of time, which continues to threaten human health; particularly that of young children. An Integrated Exposure, Uptake, and Biokinetic (IEUBK) as a human health risk model were applied to predict the Blood lead levels (BLLs) in children. A variety of data for air, soil, and water were obtained from the industrial region in Al-Dorah city in Baghdad for the period 2012- 2014. The result found that the predicted BLLs value of 11.17 µg/dL obtained from the IEUBK model was exceeding the agency's threshold of concern of 10 µg/jdL which was considered as the lowest level of concern for BLL in children, this result of the IEUBK model was in agreement with the actual value of BLLs which were taken from previous literature for 24 blood samples of school children matched for age curried out in the same Al-Dorah region. This technique propels logical comprehension of the connection between BLLs in children and environmental media in both air and soil for the pollute condition. It can control national health-based benchmarks for lead and related community public health decisions.

KEYWORDS: IEUBK; Lead pollution; Blood lead level; Soil contamination, Risk assessment.

الخلاصة

تعتبرالمياه والهواء والتربة الملوثة بالرصاص مصادر محتملة للتسمم بالرصاص لتعرضها للتلوث التراكمي بالرصاص لاكثر من مدى عقود كثيرة وهي بذلك تعد مصدر تهديد مستمر لصحة الانسان وخاصة الاطفال الذين يعتبرون الاكثر عرضة للتسمم بسبب تصرفاتهم وسلوكهم القاصر. البحث الحالي يتضمن تطبيق النموذج التجريبي للاوساط البيئية المتعددة (IEUBK)الذي انتجته منظمة البيئة الامريكية (EPA) لاحتساب المخاطر الصحية الناجمة عن التعرض لتراكيز الرصاص في التربة , الهواء والمياه والتنبؤ بمستويات الرصاص في الدم لدى الاطفال الذين يعيشون بتلك البيئات. البيانات المستعملة في هذا البحث تم جمعها من دراسات سابقة اجريت في المنطقة الصناعية في منطقة الدورة ببغداد عام 2012-2014 وشملت عدة نماذج ملوثة بالرصاص من بيئات مختلفة (الهواء والتربة والمياه) بالاضافة الى بيانات اخرى لنماذج من دم لاطفال الذين يسكنون في نفس تلك المنطقة الصناعية. بينت الدراسة ان نسبة الرصاص في الهواء والتربة (اعلى من القيم المقبولة عالميا) والمياه والتي تم ادخالها للبرنامج او الموديل اثرت على قيم مستويات الرصاص في الدم المقاسة في الموديل الحالي كانت اكثر من 10 µg/dL الذي يعتبر اقل مستوى ينصح به عالميا لمستوى الرصاص في الدم لدى الاطفال. وجدت الدراسة بان هناك تطابق في تراكيز الرصاص في الدم والتي تم التنبؤ بها في الموديل الحالي (IEUBK) مع مستويات الرصاص في نماذج الدم التي تم جمعها مسبقا بالطرق التقليدية. اضافة الى ذلك، فان نتائج البحث الحالية تؤكد بان ارتفاع مستويات الرصاص في الدم تكون متزامنة مع ارتفاع نسب تلوث الهواء والتربة بالرصاص.

INTRODUCTION

Lead (Pb) harming is viewed as the most widely recognized natural ailment of kids. This component has been utilized in a wide assortment of regular items and exercises that can radiate Pb which incorporates: industries of car batteries, paints, water pipes, leaded gasoline, and solder, crystal and ceramics, mining and smelting of lead-ores etc. [1]. The rate changes with age, financial status, the number of inhabitants in a given network and race [1]. Long-term exposure to the Pb may contribute to elevated Blood Lead Levels BLLs, especially in young children, who are more

susceptible to elevated Pb concentrations in dust and soil because of their successive hand-to-mouth and pica conduct [2]. The negative wellbeing impacts related with the component incorporate restrained mental health and hematological impacts, for example, weakness [3], because of Pb accumulation in the kidney, liver, teeth and bones [4,5]. Lead Bromide (PbBr2) gives helpful data about later and historical exposures to Pb. Truly, the examination of Pb in the entire blood is the most widely recognized and precise technique for surveying Pb introduction [1]. Pb can be distinguished in many examples of soil, air and water, just as in numerous sustenances and plants. Consequently, all people are presented to levels of Pb from numerous presentation pathways, including ingestion of soil and residue, ingestion of water, inward breath of Pb-containing particles of soil or buildup in air, and ingestion of sustenance's that have taken Pb up from soil or water. While the BLLs of children is a good indicator of Pb exposure, these include obtrusive testing and are accordingly frequently hard to acquire. Along these lines, another method is required to decide human health risk, according to blood inspecting yet which isn't intrusive

A few examinations proposed that an increasingly far reaching method for measuring Pb risks concerning children is using a regression model to anticipated BLL values from dust and soil [6]. These investigations used a multivariate direct relapse model to find an inclination factor relating soil Pb levels to BLLs. The model shows that extended soil Pb level is connected with brought blood Pb up in adolescents [3], or using site-specific exposure models, for example, the United States Environmental Protection Agency USEPA's Integrated Exposure, Uptake, and Biokinetic IEUBK model [7,8]. The IEUBK was created by the United States Environmental Protection Agency (USEPA) to predict human health risk presented by Pb contamination and elevate BLLs for kids under 7 years old utilizing the premise of data about their exposure to Pb (for example water, soil, air) [9,10].

Numerous examinations in Iraq related between natural Pb and its exposure and health assessment. These investigations discovered varying connections between soil Pb concentration and the number of individuals presented to Pb as estimated by BLLs. As of late, an investigation was conducted for Baghdad city for the Pb levels in blood related to the length of exposure to Pb by [10]. It was seen that there is an expansion of the mean of BLLs for workers 20.31 µg/dl versus 2.91 µg/dl for non-workers. This study was done on 65 male painters, generator labourer and fuel workers in Baghdad city. A study demonstrated that the fuel workers had Pb level in the blood more than generator workers and painters [10]. Another investigation was conducted in the marsh area south of Iraq by [11]. They found that there is a connection between drinking water and the concentration of Pb in the blood of people who are living and utilizing the marsh water [11]. The majority of these examinations include estimations for BLL in grown-ups, which not assent for IEUBK model value that particular for children between (0-7 years). The information gathered and confirmed was contrasted and information in various periods, which included Pb, polluted information in air, soil and savoring water, Pb concentration in blood for children which will have increasingly precise outcome.

A colossal measure of information on the prosperity effects of Pb has been procured through numerous long periods of therapeutic observation and consistent research. By correlation with most other natural toxicants, the level of vulnerability about the wellbeing impacts of Pb is very low. A portion of these impacts especially changes in the degrees of certain blood compounds and parts of kids' neurobehavioral advancement, may happen at BLLs. So it is hard to distinguish what level of Pb presentation, can be viewed as safe for newborn children and youngsters [12]. A study by Zartarian *et al*. [13] expressed that paints, drinking water, soil, and residue that contain Pb are the great wellsprings of Pb presentation in the wake of eliminating of leaded fuel other than Pb smelters and mechanical procedures [13].

An expanding number of studies detailed appropriate indications of Pb-initiated neurological or potentially conduct impacts in youngsters starting at around 10 ug/dL or even lower, with populace impacts getting to be more clear and progressively positive in the scope of 30-40 ug/dL [2]. It is important to refer to that a few scientists have an uncommon worry about the impacts of Pb on neurobehavioral execution, heme union, and fetal advancement. They guarantee that there probably won't exist a limit an incentive for Pb and that the impacts are dependable [4]. Then

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again, a few analysts and clinicians accept that the impacts that happen in youngsters at low BLLs are minor to the point that they need not be cause for concern.

After an exhaustive survey the considerable number of information, the Environmental EPA distinguished 10 ug/dL as the fixation level, at which impacts that warrant shirking start to happen [9]. In same manner, the Centers for Disease Control and Prevention (CDCP) have set up a rule of 10 ug/dL in preschool youngsters that accepted to counteract or limit Pb-related intellectual deficiencies [14]. Based on measured Pb concentrations, a biokinetic model estimates that anywhere from 15% to 70% of children living in households with pitcher pumps (These pumps typically include components made from Pb) may be at risk for elevated blood lead levels (>5 µg/dL)

In as of now look into; children's BLLs will be assessed using the IEUBK model, as indicated by changing the information parameters of the Pb concentration of air, water and soil. Since appropriate input data is as of now from accessible in literature, this research does not have to include any child participants. Indeed, incorporated evaluation incorporates two stages: [1] recreate the Pb concentration distribution in different condition media model, [2] estimate Pb consumption and the BLLs. Related objectives were to evaluate the coupled model estimates using real-world blood lead data, to quantify relative contributions by the various media, and to identify key model inputs.

MATERIALS AND METHODOLOGIES

The IEUBK Model

A windows variant: IEUBKwin for Pb in kids was discharged in 2001. The IEUBK model proselytes assessments of youth exposures to Pb in air, soil and residue, drinking water, and nourishment into forecasts of blood Pb fixations, and dangers of surpassing blood Pb centralizations of concern [13]. To help assess the dangers which Pb stances to small kids, the EPA has built up the IEUBK Model for Pb in youngsters. The reason for the model is to anticipate the degree of Pb in the blood of a youngster or a populace of kids, under a predetermined arrangement of presentation conditions, considering all wellsprings of Pb introduction [9].

The IEUBK model reenacts Pb biokinetics in children up to age 84 months and incorporates a multipath way age-subordinate presentation model and a blood Pb changeability model [9, 14]. IEUBK model is made out of two primary parts: first, the introduction area, where, the measure of Pb which a child ingests or breathes in is determined from information on A) the grouping of Pb in each applicable ecological media (for example soil, dust, sustenance, water and air), and B) data on the amount of every one of these media is ingested or breathed in by a kid every day. Indeed, this analysis probabilistically simulated multimedia exposures and estimated relative contributions of media to BLLs across all population percentiles for several age groups. As a rule, the model is expected to assess circumstances where presentation is ongoing, and the introduction levels can be sensibly depicted as far as long haul midpoints. For this situation, the anticipated blood Pb level is the normal long haul normal worth. This long haul normal worth is commonly viewed as the most proper reason for assessing wellbeing dangers from Pb. The model isn't by and by planned to permit assessment of periodic or momentary Pb exposures that reason "spikes" in BLLs [9].

In actuality, introduction and biokinetic parameters are not known for the people at a site, yet are just accessible as gathering measurements from populace contemplates (for example evaluated mean soil admission rate, assessed mean gastrointestinal ingestion division, assessed mean body weight, and so forth.). Along these lines, the model does not try to precisely foresee the BLL of anyone explicit individual but instead tries to anticipate the commonplace BLL that would be normal in a "normal" youngster. BLLs in the whole populace everything being equal, particularly those that are at the upper piece of the appropriation (e.g., the 95th percentile) are then assessed by creating the inexact circulation from the evaluated focal worth. This is accomplished by expecting the dissemination is roughly lognormal fit as a fiddle, and by applying a gauge of the level of changeability between various

youngsters. This descriptor of fluctuation is the Geometric Standard Deviation [14].

When all said is done, the model can be utilized to assess two various types of populaces. The first is the number of inhabitants in all present and additionally speculative youngsters uncovered at a similar area (e.g., at a particular home, childcare focus, play area, and so on). That is, the natural Pb levels are the equivalent for all youngsters, however admission rates, ingestion factors, and so forth, the contrast between kids, prompting various qualities for various kids inside the populace. The second kind of populace is the number of inhabitants in all youngsters in a huge zone (e.g., a network). For this situation, inconstancy in BLLs emerges not just given individual-explicit contrasts in admission and biokinetic factors, yet additionally due to contrasts in Pb focus levels in various pieces of the network. Either use of the model is satisfactory; however, the two applications ought not to be mistaken for one another [14].

Data and techniques

In either use of the model, three kinds of data are required to yield dependable forecasts of blood Pb values:

1. Pb focuses or Pb admissions from every single natural medium (soil, indoor dust, air, drinking water). The values for Pb concentration in air, soil and plant in this work were obtained according to previous studies achieved in Al-Dorah City, Baghdad at 2011 [15; 16; 17]. Various Pb exposure sources in Al-Dorah region were selected included (Al-Dorah refinery, electrical power plant, private electrical generation and other private small factories). So, the high values of Pb contamination were expected in this area due to industrial effects [16]. According to Hassan (16], Al-Dorah was classified to three areas (commercial, industrial, agricultural), 10 of air samples were collected within each area, while 25 of soil samples were collected from the surface (not exceeding 5cm depths) in the same locations of air sampled. Besides, two samples from the drinking water treatment plant in Al-Dorah district were collected and analyzed. The first site in the locality of sector 826 (St.3), which lies up to 2 km from the station of water treatment plant while the second site was in the locality of sector 834 (St.4), which lies up to 5 km from the station [15].
2. Environmental media relevant to human Pb exposure (e.g., consumption paces of soil, dust, water, air, sustenance, paint). These presentation rates are normally viewed as age-subordinate.
3. Pharmacokinetic parameters for Pb, including ingestion rates, and dissemination and freedom rates for different inside body compartments (blood, bone, delicate tissue, and so forth.). These parameters are additionally age-subordinate. The vast majority of the model information parameters (particularly those in 1 and 2, above) would be founded nearby explicit information as above. Other information gives prescribed defaults to the parameters of the IEUBK model.

The estimations of BLLs in the current work is confirmed by using 24 blood tests from younger students of a primary school located in the same area of study as in a previous study by (Abu-Timman 1988). It is vital to refer to that Al-Dorah region is a piece of Baghdad city the capital of Iraq (Fig.1). It is situated on the meander of the Tigris River, south of Baghdad. It contains petroleum processing plants, power plant and the storehouse (silo). The population of the region is around 300000.

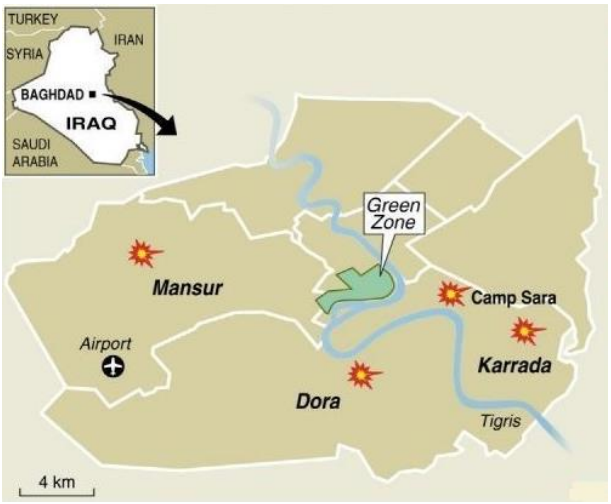

Figure 1. Map of Iraq showing the location of Al -Dorah district.

RESULTS AND DISCUSSION

Pb focuses on an assortment of introduction destinations were accumulated. The aim of this undertaking was not to create exact outcomes for a given area but instead for exhibition and elucidation of the outcomes. The default of model parameters was change by into the least and most astounding estimation of parameters of (air, water, soil). Assimilation portion rates will keep

consistent: soil 30%, dust 30%, drinking water 50 % and diet 50 % dependent on IEUBK model defaults as portrayed in the IEUBK direction manual [9]. The accompanying (Table 1) demonstrates the qualities which were gotten and connected to the IEUBK model, which surpass the standard acknowledged points of confinement except those for water.

Table 1. The Pb data in the air, soil and water of Al-Dorah region and the standard values which were applied in the IEUBK model.

Air Pb (µg/m^3) mean value (mv)	Soil Pb (ppm) mv	Pb concentration in water (µg/l) mv
2.5	268	5
Maximum permissible level		
0.15 [9]	100 [4]	10 [18]

The IEUBK model has been utilized widely in evaluating Pb risks to children where Pb contamination of residential soils is a worry. The all out number of children researched for BLLs in the industrial zone of Al-Dorah locale was 24, half of them were male and half were female [17; 19]. The younger students in this investigation were picked to be appropriate as conceivable with the IEUBK model. The number of children and their distribution as per age appears in Table 2. Additionally, Table 3 demonstrates the mean estimation of Pb in 24 blood tests for younger students (males and females) was 11.5µg/dl, with a stander meaning of 1.93. Conversely, the mean estimation of BLLs in the currently IEUBK model was 11.17 µg/dl (as per mean value in all media) with stander meaning of 1.6.

Table 2. Number of children versus age in one of the schools in the study area.

Area	Age							Total
Al-Dorah	6	7	8	9	10	11	12	
	4	3	3	4	4	2	4	24

A correlation for the present venture results (observed and anticipated geometric mean blood Pb) with three different studies is showed in Table 3. Kelany *et al*. [1] exposed that there was unimportant contrast in BLL between urban younger students and rural younger students. Nonetheless, the mean estimation of BLLs in urban children was inconsequential higher than rural children. Moreover, irrelevant contrast in BLL among boys and girls was noticed [1]. The correlation values in Table 3 confirmed that the geometric mean and confidence interval resulted in this study are similar to several other models which determined to assess the blood Pb level of children in the ambient (air, water, soil, etc.) environment. The applicable models in this table would support and validate the present results.

Table 3. Illustrate several communities blood Pb examines comparing with current study index.

Dataset	N	Observed Blood Pb (µg/dL)		Model Prediction	
		GM[a] (95% CI)	Percent>10 (95% Cl)	GM (95% Cl)	Percent>10 (95% Cl)
Study area	24	nill	11.5	10.96	11.17
Galena, KA Jasper CO, M1 [19]	111	5.2	20	4.6	18
Madison Co, [19]	333	5.9	19	5.9	23
Palmerton, PA [19]	34	6.8	29	7.5	31
GM = geometric means, Cl[b]= confidential interval					

One of the output options could be described by examining an aspect of IEUBK model simulation. The output from a single simulation run to show the variability associated with a predicted PbB concentration. This range can be demonstrated graphically by selecting the variability Geometric Standard Deviation (GSD). The density curve representing to what BLL concentration is well on the way to happen within the population as indicated by Geometric mean and GSD values as appeared in Fig. 2. At cut-off levels <10 µg/dL, the geometrical mean value was (10.96) and GSD of 1.6. According to the curve, most of the children presented to the Pb exposures recorded above will create BLLs more than 5µg/dL, which is over the reference level. In this way, intercessions ought to be made to the child's environment to guarantee their BLLs don't increase in the smallest manner.

The plot of cumulative probability distribution was represented as in Fig. 3. The output of the model is considered to be the predicted geometric mean PbB of a population of children under the same Pb exposure scenario. That portion of the upper tail that exceeds some chosen PbB level of concern indicates the fraction of the population exceeding that level when all of these children have the same exposure history.

The range of probable PbB values was determined graphically as defined by upper and lower percentiles of the distribution. The distribution curve (Fig.3) shows the probability of the population that has a blood Pb concentration (μg/dL) at a given value. As per the bend, there is roughly a 60% possibility that all population in the bend has BLL >10 μg/dL, which means no BLL is considered as safe for a child.

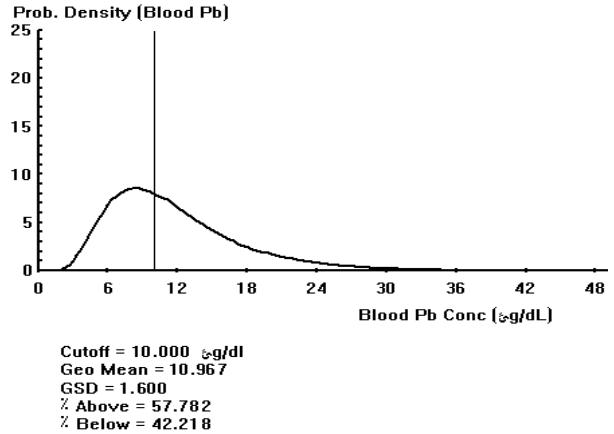

Figure 2. The density of blood Pb levels BLL spoke to anticipated qualities at cut-off degrees of <10 μg/dL.

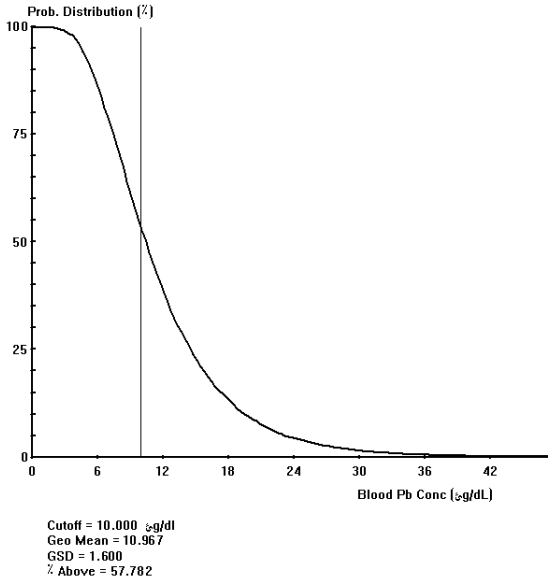

Figure 3. Dispersion curve for the mean parameter with Geometric means of 10.96.

Children used to be marked with a degree of worry for harmful impacts if their BLLs estimated 10 μg/dL or more. Since 2012, this reference level has been diminished to 5 μg/dL [10]. Any child with BLLs more than 5 μg/dL is beyond the 97th percentile and is consequently considered at incredible hazard. These presentation destinations present dangerous health impacts and that some degree of remediation/intercession is required to decrease the Pb exposure.

The IEUBK model is a valuable apparatus for anticipating BLLs in kids. It is entirely versatile and takes into consideration exact appraisal of Pb presentation in kids; it's likewise utilized for the ID of most significant introduction factors, given that adequate site explicit information is accessible.

The EPA IEUBK model is the main hazard model that has been approved for use in the superfund program for evaluating Pb dangers to youngsters where private exposures to Pb in soil and residue are known to be the significant supporters of presentation [9, 19], be that as it may, the model has a few confinements for the application expected at the RSR site which is in a private and business region of West Dallas, Texas. Although the model has been assessed for anticipating semi enduring state blood Pb fixations related with exposures of an interval or years in span, it has not been assessed for foreseeing blood Pb focuses that may happen with quickly shifting exposures, for example, those experienced during medicinal exercises at the RSR site.

The IEUBK has numerous favourable circumstances including sources of info intended to help superfund site chance appraisal, it tends to a wide scope of introduction pathways. In any case, the model likewise has some hindrance including, its failure to survey age bunches over 7 years of age or to evaluate BLLs over 30 μg/dL. It is additionally restricted to assessing just long haul exposures (introduction periods must be for in any event three months), and it can't evaluate pica exposures. Moreover, the deliberate BLLs can't coordinate with a particular kid because the model is intended to anticipate a normal BLLs fixation for a whole populace, not people [5].

CONCLUSION

Pb exposure is an ecological risk to all general communities. It ought to be noticed that the greater part of the younger students and their folks don't know about Pb exposure. A set number of air, water and soil samples were collected to evaluate the potential commitment of them to Pb exposure. The result of this research confirmed that the IEUBK model could quickly evaluate BLLs for environmental health risk assessment. The investigation inferred that the higher Pb concentration in air, soil and Plants was connected with BLLs for people in the polluted zone and contributed to Pb intake among urban children.

This strategy progresses logical comprehension of the connection between elevated amounts of BLLs in kids and the concentration of air and soil. It can manage national health based standards for Pb and related community general health decisions.

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