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BRIEF COMMUNICATION

A Denver Refugee Clinic Blood Lead Level Analysis in Refugee Females of Reproductive Age, 13–45 years, 2014–2019

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Abstract

The objective was to determine if refugee females of reproductive age (FRA) are at risk of having elevated blood lead levels (BLL). A retrospective quality improvement project conducted at a Denver community health center (9/2014–3/2019) evaluated BLLs from initial domestic medical examinations (DME) in 312 FRA refugees (13–45 years). Associations between elevated BLL and demographic factors were explored using multivariable regression analysis. Of 312 FRA refugees, BLLs ranged from < 2.0 to 26.2 mcg/dL, 5% had elevated BLLs. Of pregnant refugees (49), 4% had elevated BLLs. Afghani country of origin was positively associated with elevated BLLs, adjusting for age (FRA: Prevalence Ratio 6.90 [2.68–17.77], $p < 0.0001$). Afghani FRA refugees, irrespective of pregnancy and breast-feeding status, should have BLL testing at DME. Nationally representative evaluations of FRA refugees are needed to determine if BLL screening should be expanded to all FRA refugees, irrespective of pregnancy or breast-feeding status.

Keywords Lead · Refugees · Pregnancy · Female · Quality improvement

Introduction

New immigrant pregnant and breast feeding females arriving in the US may be at risk for elevated blood lead levels (BLL) (≥ 5 mcg/dL) due to environmental exposures and/or cultural practices [1, 2]. Screening of pregnant and breast feeding newly arriving immigrants and refugees for elevated BLL is recommended by the American College of Obstetricians and Gynecologists [3] and the Centers for Disease Control [4], respectively. These guidelines are based on the fact that lead crosses the placenta throughout pregnancy, with reports of lead detected in the fetal brain by the end of the first trimester, and is associated with delays in infant neurodevelopment [5]. Elevated BLL also is associated with gestational hypertension [6], spontaneous abortion [7], and low birth weight infants [8] and is transmitted via breast milk to infants [9].

While 2010 CDC guidelines recommend blood lead screening in pregnant and/or lactating females who have emigrated from countries with environmental lead exposure risks [10], current national guidelines do not specifically address screening for elevated BLL in immigrant and refugee females of reproductive age (FRA) between the ages of 13–45 years, in general, irrespective of a diagnosed pregnancy [3]. FRA refugees may have higher risks for undetected early pregnancy, due both to a lack of access to effective birth control and evidence-based education regarding family planning overseas and at arrival. They may also have higher rates of unplanned or planned pregnancy after arrival [11]. In this group, lead exposure in an early pregnancy, either undetected at US arrival or soon thereafter, could negatively affect both the pregnancy as well as the infant's neurodevelopmental outcome.

Currently, the prevalence of elevated BLL in refugee FRA is unknown, and there are no known studies (at the time of writing) that evaluate BLLs in refugee FRAs. This retrospective quality improvement (QI) project aimed to assess current screening practices at one clinic site in Denver,

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Colorado by determining if refugee FRAs, irrespective of pregnancy or breast feeding status, are at risk of elevated BLL and if so, should all or certain refugee FRA sub-populations be tested for elevated BLL at initial domestic medical examination (DME).

Methods

Participants and Data Collection

All FRA refugees who presented for domestic medical examination at a Denver, Colorado federally qualified health center (9/2014–3/2019) who had valid country of origin data and venous lead level results were included (n = 312). FRAs were defined as females aged 13–45 years. De-identified BLL results, age (DME date—reported birthdate), and country of origin data (extracted from overseas medical records) of FRA refugees were analyzed. The Denver Health and Hospitals Quality Improvement (QI) Committee determined this project constituted non-human subjects research QI and did not require full Institutional Review Board approval.

Measures

BLL was dichotomized using the CDC recommended reference level: normal BLL (< 5 mcg/dL) and elevated BLL (≥ 5 mcg/dL) [12]. Countries of origin were grouped when refugees were known to have fled home countries to specific accepting refugee camps or cities in other countries. Based on this geographic information, the following birth countries were grouped: Myanmar/Malaysia/Thailand (Burmese refugees), Kenya/Somalia (Somalian refugees), Bhutan/Nepal (Bhutanese refugees), and Jordan/Syria/Turkey (Syrian refugees). One refugee with Papua New Guinea country of origin was not included in the analysis, given that refugees from many countries of origin have been detained there and it was not possible to identify associated ethnicity. One refugee with US country of origin was presumed to be a data entry error at DME and was also removed from the analysis.

Analysis

Descriptive statistics of elevated BLL for FRA refugees were conducted (Table 1). A multivariable generalized linear regression analysis was used to evaluate the association between elevated BLL (dichotomous outcome: normal versus elevated BLL) and country of origin (independent variable of interest) among FRA refugees, adjusted for age. Only countries of origin with more than 10 FRA refugees were evaluated (Afghanistan, Democratic Republic of Congo, Iraq, Myanmar/Malaysia/Thailand, Bhutan/Nepal, Ethiopia, Jordan/Syria/Turkey, Kenya/Somalia, Eritrea, Cuba). Data analysis was performed with SAS version 9.4 [13].

Table 1 Baseline characteristics of refugee females of reproductive age (13–45 years)

	Average ± standard deviation (range) N = 312
Overall blood lead level (mcg/dL)	2.63 ± 1.76 (≤ 2.0–26.2)
Age (years)	26.2 ± 8.4 (13–45)
	N (%)
Elevated blood lead level	16 (5.1)
	N (%)
Age	
13–16	45 (14.4)
17–21	56 (18.0)
22–35	158 (50.6)
36–45	53 (17.0)
Status	
Not pregnant	236 (75.6)
Pregnant	49 (15.7)
Missing data	27 (8.7)

Results

Of 312 FRA, the majority (51%) was between the age of 22–35 years (interquartile range: 19–32, median: 25). BLLs ranged from < 2.0 to 26.2 mcg/dL and 5% (n = 16) of FRAs had elevated BLLs. Over 75% were known to not be pregnant at DME, and of this non-pregnant group, 5% (n = 14) had elevated BLL, ranging from 5.3 to 26.2. Of the 16% (n = 49) of FRA refugees who had a positive pregnancy test at initial DME, 4.0% (n = 2) had an elevated BLL (5.3 and 6.8 mcg/dL).

FRA refugees who had elevated BLL were 6.90 times as likely to be from Afghanistan compared to those refugees without an elevated BLL, adjusted for age (FRA: PR 6.90 [2.68–17.77], p < 0.0001) (Table 2). Other countries of origin had ranges of FRA refugee arrivals from 1 (seven countries) to 44 individuals (Democratic Republic of Congo). Prevalence ratios for country groupings of Jordan/Syria/Turkey (i.e., Syrian refugees) and Kenya/Somalia (i.e., Somali refugees) as well as Eritrea were non-calculable due to having no elevated BLLs identified in these groups.

Discussion

It is known that refugee children are at risk for elevated BLL, and recent data show that Afghani refugee children are at higher risk [14]. However, the prevalence of elevated BLL in pregnant and breast-feeding refugees, and in FRA refugees in general, is unknown. Current recommendations do not require BLL testing at initial DME for all FRA refugees, irrespective of known pregnancy or breast-feeding status. The results of our QI evaluation suggest that all Afghani FRA refugees, irrespective of pregnancy and breast-feeding status, should have BLL testing at DME. This group and potentially other refugee sub-populations may have higher rates of elevated BLL that would negatively affect early undetected pregnancies at arrival or soon thereafter. However, due to small sample size from other countries in this analysis, we were unable to evaluate other refugee sub-populations. Given the existing data on elevated BLLs in Afghani children [14] and our findings of statistically significant elevated BLLs in Afghani FRA refugees, it would be prudent to screen all Afghani refugee infants, children and FRA at DME.

There were several limitations of this QI project, including a small sample size and only 28 countries of origin represented; therefore, it is difficult to draw any conclusions of country of origin risk, outside of Afghanistan. Larger national studies need to be conducted to evaluate risk of FRA refugees for elevated BLL. Given that this was a single site evaluation of elevated BLL, our findings are not generalizable to other refugee populations who arrive in other regions of the US. Because refugees may have resided in multiple countries, country of origin may not be a complete reflection of refugees' previous travel and residential history and could lead to a false association of elevated BLL to country of origin data. Given that there are variable definitions of FRA used in other studies, our definition (13–45 years) may have underestimated the total number of FRA refugees at risk. Lastly, date of birth for refugees may be unknown or estimated, potentially affecting the calculated age of refugees who were screened and either over-estimating or under-estimating the group of FRA refugees; however, we suspect that this would result in non-differential misclassification, thus biasing our results towards the null.

Table 2 Prevalence ratios of EBLL by Country of origin

Birth country	Crude model		Age adjusted model	
	Prevalence ratio [CI]	P-value	Adjusted prevalence ratio [CI]	Adjusted P-value
Afghanistan (N = 53)	6.28 [2.44–16.12]	0.0001	6.90 [2.68–17.77]	< 0.0001
Democratic Republic of Congo (N = 44)	0.87 [0.20–3.70]	0.85	0.94 [0.21–4.11]	0.93
Iraq (N = 30)	0.63 [0.09–4.58]	0.65	0.56 [0.08–4.07]	0.56
Myanmar/Malaysia/Thailand (N = 28) (Bhutanese refugees)	0.67 [0.09–4.93]	0.70	0.71 [0.10–5.17]	0.74
Bhutan/Nepal (N = 23)	0.84 [0.12–6.06]	0.86	0.88 [0.12–6.40]	0.90
Ethiopia (N = 21)	0.92 [0.13–6.66]	0.94	0.83 [0.11–5.99]	0.85
Jordan/Syria/Turkey (N = 20) (Syrian refugees)	NC	NC	NC	NC
Kenya/Somalia (N = 21) (Somalian refugees)	NC	NC	NC	NC
Eritrea (N = 17)	NC	NC	NC	NC
Cuba (N = 14)	1.42 [0.20–9.99]	0.73	1.21 [0.17–8.59]	0.85

NC not calculable

Conclusions

This QI project demonstrated that FRA refugees from Afghanistan were at increased risk for elevated BLL, irrespective of pregnancy and breast-feeding status. Given that newly arriving refugee FRA may be at risk of early pregnancy soon after US arrival [12], it would be prudent to test all refugee FRA for EBLL at initial screening evaluations until large national studies are conducted to further delineate sub-population specific risks.

Compliance with Ethical Standards

Ethical Approval Ethics approval and consent to participate as QI from the Denver Health and Hospitals Quality Improvement Committee. DME was performed under contract with the Colorado Department of Human Services/Colorado Refugee Services Program.

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