Research

Stillbirth in rural Bangladesh: arsenic exposure and other etiological factors: a report from Gonoshasthaya Kendra

Nicola Cherry,[a] Kashem Shaikh,[b] Corbett McDonald[c] & Zafrullah Chowdhury[b]

Objective To use data collected by Gonoshasthaya Kendra, a large nongovernmental organization providing health care to some 600 villages, to describe the epidemiological pattern of stillbirth and any additional contribution made by arsenic contamination of hand-pump wells in Bangladesh.

Methods Completed pregnancies and outcomes (n = 30 984) for two calendar years, together with existing data on 26 socioeconomic and health factors were selected for study. The health care in these villages was administered from 16 geographical centres; information on the average arsenic concentration in each centre was obtained from the National Hydrochemical Survey. After univariate analysis, a multivariate, multilevel, logistic model for stillbirth was developed. The additional effect of arsenic was calculated having adjusted for all potential confounders thus identified.

Findings The overall stillbirth rate was 3.4% (1056/30 984) and increased with estimated arsenic concentration (2.96% at < 10 µg/l; 3.79% at 10 µg/l to < 50 µg/l; 4.43% at ≥ 50 µg/l). Having adjusted for 17 socioeconomic and health factors, the odds ratios estimated for arsenic (with < 10 µg/l as reference) remained raised: 1.23 (95% confidence interval, CI: 0.87–1.74) at 10 µg/l to < 50 µg/l and 1.80 (95% CI: 1.14–2.86) at 50 µg/l or greater.

Conclusion An increased risk of stillbirth is associated with arsenic contamination. This risk, substantial enough to be detected by an ecological approach and not readily attributable to unmeasured confounding, is essentially preventable and all efforts must be made to protect women at high risk.

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Une traduction en français de ce résumé figure à la fin de l'article. *Al final del artículo se facilita una traducción al español.* الترجمة العربية لهذه الخلاصة في نهاية النص الكامل لهذه المقالة.

Background

Stillbirth is a major cause of pregnancy loss, particularly in poor countries. In sub-Saharan Africa and southern Asia, some 5% of pregnancies end in this way, whereas in Europe and North America the proportion is generally less than 1%. In the latter regions, much is known about such causal factors as hypertension, obesity, eclampsia, advancing age and smoking.[1] In poor countries, there has been much less research, and the main concern has been for early pregnancy, inadequate nutrition, endemic malaria, stature and poor physique, all or any of which may have an important role.[2] Our immediate need is to determine whether, in Bangladesh, the widespread arsenic contamination of water in hand-pump tubewells is potentially hazardous for pregnant women. Though this question could be approached ecologically with the considerable information on the geographical distribution of arsenic in wells based on the National Hydrochemical Survey, together with stillbirth rates by district, the possibility of confounding by socioeconomic factors and health status also has to be excluded.

Serious natural contamination of water with arsenic and other minerals in village hand-pump tubewells in Bangladesh and West Bengal is well documented,[3] as are the skin lesions that result.[4–10] A wide range of other types of disease, mainly from occupational exposure to inhaled arsenic, have included internal cancers of the lung and other organs and various chronic inflammatory diseases, but effects on the outcome of pregnancy have not been clearly identified.[11] However, the longstanding use of arsenic as an abortifacient, together with results from animal studies,[12] suggests that such effects are not improbable, and there is evidence that arsenic concentrations in the urine of pregnant women reflect their level of chronic exposure.[13] In 2001, a study in Bangladesh of pregnancy outcomes in 192 women, half in a village with high arsenic levels, found 17 stillbirths compared with seven in a similar village with low levels.[14] A more recent study of 533 women drawn randomly from 74 villages, mostly with high arsenic concentrations (mean 277 µg/l; median 116 µg/l) showed evidence of increased risk of fetal and infant

[a] Community and Occupational Medicine Program, University of Alberta, Edmonton, AB, Canada.
[b] Gonoshasthaya Kendra, Dhaka, Bangladesh.
[c] Department of Occupational and Environmental Medicine, National Heart and Lung Institute, Imperial College London, London, England.
Correspondence to Nicola Cherry (e-mail: nicola.cherry@ualberta.ca).
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death.[15] This study, although based on only 48 stillbirths, allowed analysis of reproductive history and educational status by logistic regression.[15] A study of 202 pregnant women identified from a cross-sectional survey of almost 8000 people in 21 West Bengal villages found evidence of a significant increase in stillbirth at concentrations of ≥ 200 µg/l.[16] However, a study of 2006 pregnant women in three selected *upazillas* (subdistricts) found no association with stillbirth.[17]

There is still a requirement for evidence based on reliable data in well-supervised large populations exposed to arsenic over a range of concentrations. These requirements are largely met by Gonoshasthaya Kendra (GK; the People's Health Centre), a large, well established nongovernmental organization, which currently provides comprehensive health care for the entire population of about one million in some 600 villages, spread across four of Bangladesh's six main divisions. Most of the villages in the GK network are located in districts where the average arsenic concentration in hand-pump tubewells is low (< 50 µg/l), but many are in areas with average concentrations well above that; in addition, there is enormous variation between and within villages. Cross-sectional and case-referent surveys of skin lesions in a large sample of GK villages have shown an average prevalence of 0.37% at concentrations < 5 µg/l, rising to 6.84% at > 50 µg/l.[18,19]

As GK has always maintained a complete census of residents in its villages and has systematically recorded all pregnancies with outcome, together with some 30 health and socioeconomic variables, these data should provide useful information on the epidemiology of stillbirth in this population of over a million residents in rural Bangladesh against which any additional effect of arsenic can be assessed.

Methods

Completed pregnancies with outcome (live birth or stillbirth) for two calendar years (Bangla 1409 and 1410) were selected for study. These years (falling within 2001–2003 on the Christian calendar) were the most recent to have been checked for accuracy and completeness. The data available were for nearly 600 villages grouped geographically into 16 centres. Average arsenic concentrations for these centres were obtained from the published statistics of the National Hydrochemical Survey.[3] The averages used were those for the 13 *upazillas* in which the centres were located; three centres were in the same *upazilla* and two in another. Each average was based on seven to 14 wells tested, with values ranging from < 1 µg/l to 81 µg/l. Nine centres were in *upazillas* with mean arsenic concentration < 10 µg/l, five in *upazillas* 10 µg/l to < 50 µg/l and two in *upazillas* estimated to have arsenic concentration of ≥ 50 µg/l. All the information about the family, pregnancy, delivery and outcome was taken from the records routinely collected about each pregnancy and already coded by GK.

Paramedics attached to the villages recorded the information. The nature of the data reflects obstetric practice by GK in rural Bangladesh and relies on informed judgement by the GK-trained paramedics. Low birth weight, for example, does not reflect an objective measure, because neonates were not weighed at birth, but rather it reflects the paramedic's opinion as to whether the weight was low or very low relative to other births in the area; similarly the presence of anaemia was assessed by clinical rather than laboratory indicators. Other possible differences from practice in Europe and North America include the measurement of the length of gestation and recording of neonates observed to breathe but failing to establish viable respiration as stillbirths. In multiple births, the stillbirth of one fetus was treated as a pregnancy ending in stillbirth and the presence of any male among multiple births was treated as a male outcome of the pregnancy.

Role of the funding source

The funding source had no role in study design, collection, analysis or interpretation, in the writing of the report or in the decision to submit.

Ethics

The project was considered and approved by the University of Alberta Health Research Ethics Board.

Statistical procedures

After cross-tabulation of each factor by outcome (live or stillbirth), a reference category was chosen for each, consistent with both prior knowledge of risk of stillbirth and the data specific to this study. For example, old and young mothers are at high risk of stillbirth; in these data, women younger than 21 years and age 30 years or older had higher rates and the reference category was chosen as age 21–30 years. As pregnancies clustered within the 16 centres, a logistic model was fitted (using gllamm within Stata 9) with stillbirth as the outcome and centre-specific random intercepts. First, each socioeconomic, health and exposure factor was entered individually as a fixed effect in this two-level model. A multivariate model was then fitted including all factors other than arsenic, with centre again as a random effect. The final model without arsenic included only factors significantly associated with stillbirth at $P < 0.05$. Arsenic exposure, as dummy variables contrasting 10 µg/l to < 50 µg/l, and ≥ 50 µg/l with < 10 µg/l, was then added to this best multilevel model to estimate any additional risk associated with concentrations at these two higher levels, having adjusted for potential confounders.

Findings

Information was available on outcome for 30 984 deliveries of which 1056 (3.4%) ended in stillbirth. Rates varied with estimated arsenic concentration in the drinking water: 2.96% (499/16 860) at < 10 µg/l, 3.79% (404/10 669) at 10 µg/l to < 50 µg/l and 4.43% (153/3455) in the centres with ≥ 50 µg/l. When each of 26 socioeconomic and health factors were examined individually, six (paternal smoking, malnutrition, treatment for pre-eclampsia or eclampsia, absence of antenatal care and payment of the GK insurance premium) were not related to risk of stillbirth and were not considered further. Three factors (food shortage in the home, anaemia and albumin present in urine), were related to stillbirth in univariate analysis but not after adjustment for other factors in a multivariate model. Maternal death, which occurred in less than 1% of deliveries, was highly related to stillbirth, but only after allowance for other factors: it is included, together with the remaining 16 factors in Table 1, showing the distribution of each of the factors contributing to the multivariate model, together with their univariate odds ratios. Higher rates of stillbirth were associated with a male

Table 1. **Study population with univariate (within centre) estimates of stillbirth risk**[a]

Factors[b]	Pregnancies with missing data (*N*, *s*)	Pregnancies with complete data (*N*, *s*)	Pregnancies with complete data as % of total (*N*, *s*)	Univariate odds ratio (95% CI)
Sex: Male	19, 4	15 980, 595	51.6, 56.6	1.24 (1.09–1.40)
Multiple births	1, 1	132, 20	0.4, 1.9	5.20 (3.21–8.43)
Age:	–			
< 21 years		8916, 368	28.8, 34.8	1.44 (1.26–1.65)
≥ 31 years		3462, 145	11.2, 13.7	1.53 (1.26–1.84)
Previous pregnancies:	1, 1			
0		9597, 434	31.0, 41.1	1.76 (1.53–2.03)
3–6		6516, 215	21.0, 20.4	1.27 (1.07–1.51)
≥ 7		538, 31	1.7, 2.9	2.45 (1.67–3.59)
Previous stillbirth:	–			
1		2000, 93	6.5, 8.8	1.42 (1.14–1.77)
> 1		871, 60	2.8, 5.7	2.29 (1.74–3.00)
Low socioeconomic status	–	24 720, 904	79.8, 85.6	1.55 (1.29–1.86)
Maternal education:	–			
No schooling		22 424, 783	72.4, 74.1	1.32 (1.11–1.56)
> 4 years		1536, 92	5.0, 8.7	2.39 (1.84–3.10)
Paternal education:	–			
No schooling		22 644, 802	73.1, 75.9	1.41 (1.19–1.67)
> 4 years		1472, 82	4.8, 7.8	2.30 (1.75–3.02)
Maternal smoking: Yes	272, 33	778, 8	2.5, 0.8	0.29 (0.14–0.58)
Mother: high blood pressure	8, 0	78, 12	0.3, 1.1	5.59 (2.99–10.45)
Mother: oedema	29, 9	558, 53	1.8, 5.1	3.12 (2.33–4.18)
Gestation:	6, 6			
28–32 weeks		781, 136	2.5, 13.0	9.23 (7.44–11.45)
33–36 weeks		9710, 442	31.3, 42.1	2.15 (1.86–2.47)
≥ 38 weeks		1473, 53	4.8, 5.0	1.69 (1.26–2.27)
Birth weight:	77, 31			
Low		424, 84	1.4, 8.2	12.13 (9.17–16.04)
Very low		41, 29	0.1, 2.8	86.24 (43.38–171.45)
Prolonged labour	4, 1	649, 161	2.1, 15.3	11.85 (9.75–14.41)
Excess bleeding	4, 1	182, 49	0.6, 4.6	11.51 (8.22–16.14)
Death of mother	5, 1	246, 6	0.8, 0.6	0.97 (0.42–2.24)
Home delivery	31, 5	28 829, 840	93.1, 79.9	0.25 (0.21–0.29)
Arsenic concentration:	–			
10 µg/l to < 50 µg/l		10 669, 404	34.4, 38.3	1.22 (0.95–1.58)
≥ 50 µg/l		3455, 153	11.2, 14.5	1.51 (1.08–2.13)

CI, confidence interval; *s*, stillbirths.
[a] *N* = 30 984 deliveries, *s* = 1056 stillbirths.
[b] Reference category omitted, but can be inferred.

fetus, multiple birth, mother's age less than 21 years or more than 30 years, no previous pregnancy or three or more pregnancies, one or more previous stillbirths, lower socioeconomic status (as assessed by GK for purposes of payment), no schooling or schooling beyond four years in either the father or the mother, maternal high blood pressure, oedema, gestation above or below the mode of 37–38 weeks, low or very low birth weight, prolonged labour and excess bleeding during labour. Home delivery and maternal smoking were both associated with a lower risk of stillbirth.

In a multivariate analysis, including the 30 486 pregnancies (971 stillbirths) with no missing data, largely the same factors were found, but pregnancies in young women, multiple previous pregnancies, no schooling for mothers and extended schooling for fathers, were no longer significant (Table 2). Having allowed for all other factors, maternal death seemed to be protective for the fetus, and maternal smoking and home delivery remained negatively associated with risk, the latter reflecting hospital delivery of high-risk cases. In the final analysis (Table 2), the effect of arsenic was estimated having allowed for all factors significantly related to stillbirth: the

dose response between arsenic concentration and stillbirth was not diminished. The adjusted odds ratios (with < 10 µg/l as the reference) were 1.23 (95% confidence interval, CI: 0.87–1.74) at 10 µg/l to < 50 µg/l, and 1.80 (95% CI: 1.14–2.86) at ≥ 50 µg/l.

Table 2. **Multivariate models of factors associated with stillbirth: logistic regression**[a]

Factors[b]	Final model without arsenic	Final model including arsenic
	Odds ratio (95% CI)	Odds ratio (95% CI)
Sex: Male	1.21 (1.06–1.39)	1.22 (1.06–1.39)
Multiple birth	3.07 (1.65–5.68)	3.07 (1.66–5.69)
Age:		
≥ 31 years	1.59 (1.28–1.97)	1.58 (1.28–1.96)
Previous pregnancies:		
Nil	1.81 (1.55–2.11)	1.81 (1.55–2.11)
Previous stillbirth:		
1	1.88 (1.46–2.41)	1.86 (1.45–2.39)
> 1	2.29 (1.64–3.20)	2.27 (1.63–3.17)
Low socioeconomic status	1.71 (1.38–2.12)	1.70 (1.37–2.10)
Maternal education:		
> 4 years	2.76 (2.12–3.59)	2.76 (2.12–3.59)
Paternal education:		
No schooling	1.43 (1.19–1.73)	1.44 (1.20–1.74)
Maternal smoking: Yes	0.19 (0.09–0.41)	0.19 (0.09–0.42)
Mother: high blood pressure	4.22 (1.95–9.13)	4.27 (1.97–9.23)
Mother: oedema	1.80 (1.26–2.57)	1.79 (1.25–2.56)
Gestation:		
28–32 weeks	6.58 (5.10–8.47)	6.57 (5.10–8.46)
33–36 weeks	1.83 (1.57–2.14)	1.83 (1.57–2.13)
≥ 38 weeks	1.43 (1.04–1.99)	1.42 (1.03–1.97)
Birth weight:		
Low	14.70 (10.28–21.02)	14.73 (10.30–21.06)
Very low	65.28 (29.12–146.37)	63.73 (28.42–142.89)
Prolonged labour	6.49 (5.03–8.39)	6.48 (5.02–8.38)
Excess bleeding	1.73 (1.09–2.73)	1.73 (1.09–2.74)
Death of mother	0.03 (0.01–0.09)	0.03 (0.01–0.09)
Home delivery	0.34 (0.28–0.42)	0.34 (0.28–0.42)
Arsenic concentration:		
10 µg/l to < 50 µg/l	–	1.23 (0.87–1.74)
≥ 50 µg/l	–	1.80 (1.14–2.86)

[a] $N = 30\,486$ deliveries, 971 stillbirths.
[b] Reference category omitted, but can be inferred.

Discussion

These analyses were made possible by the existence of data by geographical subdistricts for the incidence of stillbirth, average arsenic concentration in tubewells and extensive socioeconomic and health information on all pregnancies in the study. It is remarkable that the GK network of nearly 600 villages together with the recent National Hydrochemical Survey could provide these data in analysable form. However, certain limitations exist. First, the criteria for stillbirth used by the paramedics might have not excluded a few very early neonatal deaths, especially where the delivery was unattended. Second, the socioeconomic information recorded, though collected in accord with training and instructions, was not standardized. Third, the average exposures are based on only 7–14 wells per *upazilla* and, as there is great local variation within and between villages, these may poorly reflect the arsenic ingestion of pregnant woman individually. A possibility of systematic error occurs in recording information about birth weight and other events at the time of delivery by a paramedic aware that a stillbirth had occurred. None of these limitations, however, is likely to bias upward any estimate of arsenic-related risk.

We believe therefore that the general epidemiological pattern of stillbirth in GK villages is probably reliable and a useful indication of the situation in rural Bangladesh more generally. We believe too that the observed gradient in arsenic-related risk of stillbirth, having taken account of socioeconomic and health factors, is valid and may, if anything, provide an underestimate. This would occur if arsenic in drinking water is associated with other health effects in the mother or fetus (such as short gestation or low birth weight) treated as confounders in this analysis. The high rate of misclassification of individual exposure is also likely to result in an underestimate of the dose–response gradient. We know that about one in four of wells in *upazillas* classified as 10 µg/l to < 50 µg/l had concentrations of ≥ 50 µg/l and conversely that some 30% of wells in *upazillas* classified at the higher level had concentrations < 50 µg/l.[19] Thus, while ecological exposure estimates may be appropriate for characterizing high risk area – and so focusing public-health intervention – they are more limited in estimating the underlying risk for individuals.

As such, the approach adopted here is an imperfect substitute for a more detailed – and costly – prospective cohort investigation based on a large sample of pregnancies with individual assessment of exposure. Such a study, which is now being planned within GK, will entail the routine identification by paramedics of all pregnancies in some 25 villages over a two-year period, with follow-up to determine outcome. Arsenic exposure will be estimated individually by analysis of well water in current use and, where possible, urine routinely collected in early pregnancy, for cases of stillbirth and congenital abnormality, together with a sample of non-cases. The findings may also help to elucidate some of the more puzzling aspects of the present

study, for example the effects of maternal smoking and the influence of education continued beyond four years.

In the meantime, this study and previous reports show that arsenic in drinking water is an important hazard in pregnancy, and every effort is needed to protect women at high risk. ■

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Competing interests: None declared.

Résumé

Mortinaissances dans le Bangladesh rural : exposition à l'arsenic et autres facteurs étiologiques

Objectif Utiliser les données collectées par Gonoshasthaya Kendra, une importante organisation non gouvernementale délivrant des soins de santé à quelque 600 villages, pour décrire le schéma épidémiologique des mortinaissances et l'éventuelle contribution supplémentaire due à la contamination par l'arsenic des puits à pompe manuelle au Bangladesh.

Méthodes On a sélectionné pour l'étude, sur deux années calendaires, un certain nombre de grossesses menées à terme et leur issue (n = 30 984) et relevé les données disponibles pour 26 facteurs socioéconomiques et sanitaires. Les soins de santé dans ces villages étaient administrés à partir de 16 centres géographiques, les valeurs des concentrations d'arsenic dans chacune de ces zones administratives étant fournies par l'Enquête hydrochimique nationale. Après application d'une analyse univariée, on a mis au point un modèle de régression logistique multivariée et multiniveaux de la mortinaissance. On a déterminé l'effet additionnel de l'arsenic en pratiquant des ajustements pour l'ensemble des facteurs de confusion potentiels.

Résultats Le taux global de mortinaissance était de 3,4 % (1056/30 984) et augmentait avec la concentration d'arsenic estimée (soit 2,96 % pour moins de 10 µg/l d'arsenic ; 3,79 % entre 10 µg/l et 50 µg/l et 4,43 % pour 50 µg/l et plus). Une fois ajusté pour 17 facteurs socioéconomiques et sanitaires, l'odds ratio estimé pour l'arsenic (en prenant comme référence une concentration < 10 µg/l) restait élevé : 1,23 [intervalle de confiance à 95 % (IC) : 0,87 – 1,74] entre 10 µg/l et 50 µg/l et 1,80 (IC à 95 % : 1,14-2,86) pour 50 µg/l et plus.

Conclusion La contamination par l'arsenic est associée à un risque accru de mortinaissance. Ce risque, dont l'ampleur est suffisante pour être détectée par une approche écologique et qu'on ne peut attribuer facilement à un facteur de confusion non mesuré, peut pour l'essentiel être prévenu et tous les efforts doivent être consentis pour protéger les femmes à haut risque.

Resumen

Mortinatalidad en el Bangladesh rural: exposición a arsénico y otros factores etiológicos

Objetivo Utilizar los datos reunidos por Gonoshasthaya Kendra, una gran organización no gubernamental que dispensa atención de salud en unas 600 aldeas, para determinar el perfil epidemiológico de la mortinatalidad y el posible efecto adicional sobre esa variable de la contaminación por arsénico de los pozos con bomba manual en Bangladesh.

Métodos Se seleccionaron para el estudio los embarazos llevados a término y los resultados (n = 30 984) correspondientes a dos años civiles, junto con los datos existentes sobre 26 factores socioeconómicos y sanitarios. La atención de salud en esas aldeas se administraba desde 16 centros geográficos; a partir del Nacional Hydrochemical Survey se obtuvo la información sobre la concentración media de arsénico correspondiente a cada centro. Tras realizar un análisis unifactorial, se elaboró un modelo logístico multifactorial de varios niveles para la mortinatalidad. El efecto adicional del arsénico se calculó teniendo en cuenta todos los factores de confusión potenciales así identificados.

Resultados La tasa de mortinatalidad global era del 3,4% (1056/30 984) y aumentaba con la concentración de arsénico estimada (2,96% a < 10 µg/l; 3,79% a cifras de entre 10 µg/l y 50 µg/l; y 4,43% a valores ≥ 50 µg/l). Ajustando los valores en función de 17 factores socioeconómicos y sanitarios, las razones de posibilidades estimadas para el arsénico (con < 10 µg/l como referencia) seguían siendo altas: 1,23 (intervalo de confianza del 95%, IC95%: 0,87-1,74) a entre 10 µg/l y 50µg/l, y 1,80 (IC95%: 1,14 - 2,86) a valores ≥ 50 µg/l.

Conclusión La contaminación por arsénico lleva asociado un mayor riesgo de mortinatalidad. Este riesgo, suficientemente importante para ser detectado mediante estudios ecológicos y difícilmente atribuible a factores de confusión no determinados, es en último término prevenible. Debe hacerse todo lo posible para proteger a las mujeres en situación de alto riesgo.

ملخص

الإملاص (موت الجنين داخل الرحم) في أرياف بنغلاديش: التعرُّض للزرنيخ والعوامل المسبِّبة الأخرى

الغرض: الاستفادة من المعطيات التي جمعتها منظمة غونوشاثايا كندرا، وهي منظمة غير حكومية كبيرة تقدم الرعاية الصحية لما يزيد على 600 قرية، في وصف النموذج الوبائي للإملاص (موت الجنين داخل الرحم) ومساهمة التلوث بالزرنيخ في الآبار التي تنزح بمضخات يدوية في بنغلاديش في ذلك.

الطريقة: اختيرت 30 984 من الحمول المستكملة وحصائلها خلال سنتين مع المعطيات المتعلقة بـ 26 عاملاً من العوامل الاقتصادية والاجتماعية والصحية لدراستها. وتدار الرعاية الصحية في القرى المدروسة بواسطة 16 مركزاً جغرافياً، وقد حصلنا على معلومات حول التركيز الوسطي للزرنيخ في كل

مركز من واقع المسح الوطني المائي الكيميائي. وأجرينا تحليلاً وحيد المتغير، وأعددنا نموذجاً لوجستياً متعدد المتغيرات، ومتعدد المستويات. وحُسب التأثير الإضافي للزرنيخ مع إجراء تعديلات للعوامل المصاحبة المحتملة التي تم التعرف عليها آنذاك.

الموجودات: بلغ معدل الإملاص 3.4% (1056 من أصل 30 984 حمل) وقد ازداد هذا المعدل مع ازدياد التركيز المقدَّر للزرنيخ، (فقد بلغ هذا المعدل 2.96% عندما كان تركيز الزرنيخ أقل من 10 مكروغرام/لتر، ليصبح 3.76% عند تراوح تركيز الزرنيخ بين 10 مكروغرام/لتر وأقل من 50 مكروغرام/لتر، وأصبح 4.43% عندما زاد تركيز الزرنيخ عن 50 مكروغرام/لتر). وبعد تصحيح نسبة الأرجحية المقدَّرة للزرنيخ لتأخذ في الحسبان 17 عاملاً من العوامل الاقتصادية والاجتماعية والصحية، لوحظ ازدياد مطرد فيه (عند اعتبار قيمته التي تقل عن 10 مكروغرام/لتر قيمة مرجعية)؛ فأصبحت نسبة الأرجحية 1.23 عند تراوح تركيز الزرنيخ بين 10 مكروغرام/لتر وأقل من 50 مكروغرام/لتر (بفاصلة ثقة 95% إذ تراوحت نسبة الأرجحية بين 0.87 و1.74)، ثم أصبحت نسبة الأرجحية 1.80 عندما زاد تركيز الزرنيخ عن 50 مكروغرام/لتر (بفاصلة ثقة 95% إذ تراوحت نسبة الأرجحية بين 1.14 و2.86).

الاستنتاج: يترافق ازدياد احتمال خطر الإملاص (موت الجنين داخل الرحم) مع التلوث بالزرنيخ، وهو خطر واضح بما يكفي لكشفه بالأساليب البيئية، ولا يمكن أن يعزى بسهولة إلى عوامل مضافة صعبة القياس؛ ما يجعل من الممكن اتقاء الإملاص إلى حد كبير، ويوجب بذل جهود كبيرة لحماية النسوة من هذا الخطر.

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