

**Relationship Between  
Nitrate Contamination of Ground Water And  
Methemoglobin Level Among Infants  
In Jabalia, Gaza and Khanyounis**

By

Student name: **Ahmed Abd El Hamid Abu Naser**

Registration No: **20011680**

Supervisor: **Dr. Nahed Ghbn**

Co-Supervisor: **Dr. Randa Al Khoudary**

Master thesis submitted and accepted, date **11.05.2003**

**The names and signatures of the examining committee members as follows:**

1- Dr. Nahed Ghbn	<b>Head of Committee</b>	Sig. <u>Nahed</u>
2- Dr. Yehia Abed	<b>Internal Examiner</b>	Sig. <u>Yehia</u>
3- Dr. Mohammed Al-Agha	<b>External Examiner</b>	Sig. <u>Mohammed Al-Agha</u> May 124
4- Dr. Randa Al Khoudary	<b>Member</b>	Sig. <u>Dr. Randa Al Khoudary</u>

**Al- Quds University**

**May 2003**

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## مستخلص

تهدف هذه الدراسة إلى تقدير العلاقة بين تركيز النترات في مياه الشرب ومعدل الميثيموجلوبين لدى الأطفال في مناطق جباليا، غزة وخانيونس. هذه دراسة وصفية اعتمدت التحليل الإحصائي الوصفي إضافة لدراسة العلاقة مابين المتغيرات المختلفة للدراسة التي أنجزت في 12 مركز من مراكز الرعاية الصحية الأولية التابعة لوزارة الصحة، حيث شملت 338 طفلاً ممن تواجدوا خلال مرحلة الدراسة للتطعيم، تم جمع البيانات بواسطة استبانة تم تعبئتها من خلال مقابلة مباشرة مع الأمهات في المراكز الصحية، وأخذ عينات من دم الأطفال لتقدير معدل الميثيموجلوبين وصورة الدم الكاملة، إضافة لعينات من مياه آبار الشرب خلال فترة الدراسة التي استمرت لمدة ستة شهور من يونيو حتى نوفمبر 2002.

أظهرت الدراسة أن تركيز النترات في مصادر مياه الشرب له علاقة قوية بمعدل نسبة الميثيموجلوبين، فقد كان أعلى معدل للميثيموجلوبين للأطفال في خانيونس حيث أعلى معدل النترات في مياه الشرب. ارتفعت معدلات الميثيموجلوبين عن 5% لدى 53.2% من أطفال خانيونس، 51% من جباليا و 45.8% من أطفال غزة، وأن نسبة الميثيموجلوبين أعلى لدى الأطفال اللذين تتراوح أعمارهم من 3.1 شهر إلى 6 شهور من الأطفال اللذين أعمارهم 3 شهور فمادون، إضافة لعلاقة عكسية مع الرضاعة الطبيعية و طردية مع الرضاعة الصناعية، ولارتفاع الميثيموجلوبين تأثير سلبي على نسبة الهيموجلوبين، زيادة الوزن و النمو. بينت الدراسة أن مصادر المياه هي أحد العوامل الرئيسية في رفع نسبة الميثيموجلوبين، فقد ارتفعت النسبة في حال استخدام مياه البلديات، الخزانات أو الآبار الخاصة والمياه المغلية، وبالعكس مع المياه المعالجة.

إجمالي الدراسة أظهرت أن نسبة النترات في آبار مياه الشرب في خانيونس و جباليا و غزة أعلى من المعدل المسموح به حسب منظمة الصحة العالمية، والتي تناسبت طردام مع معدلات الميثيموجلوبين لدى الأطفال، بالإضافة إلى أن النترات شكل أهم عوامل الخطر لزيادة الميثيموجلوبين وهذا يظهر مدى خطورة الرضاعة الصناعية للأطفال الأقل من 6 شهور باستخدام مياه تتجاوز النترات فيها الحد المسموح به، بالإضافة لضرورة اختيار مصدر مناسب للمياه المستعملة لهؤلاء الأطفال.



## Abstract

A cross-sectional study was carried out in Gaza Strip-Palestine in 2002. The aim of this study was to determine the relationship between nitrate concentration in drinking water wells and Met-Hb level of infants in Jabalia, Gaza and Khanyounis. The study was conducted at 12 governmental primary health care centers, covering a study population consisted of 338 infants who were attending for vaccination. Data was collected through a standardized questionnaire face to face with infants' mother at the centers, blood samples for Met-Hb and CBC and samples from the drinking water wells obtained during the study period between June and November 2002.

The high Met-Hb level was strongly associated with nitrate concentration in drinking water wells. The highest average of Met-Hb level had been detected in Khanyounis, as a response to the highest average of the observe nitrate concentration, Met-Hb level exceed 5% in 53.2% of infants from Khanyounis, 51% of infants from Jabalia and 45.8% from Gaza . There is a positive relationship between infants of age 3.1 to 6 months and high Met-Hb level, and negative relationship between exclusive breastfeeding and high level of Met-Hb. Moreover, it was noticed a significant positive relationship between the high Met-Hb level and supplementary feeding. A significant negative impact of high Met-Hb level on the Hb level, weight gaining and growth of infants also had been noticed. The study also demonstrates clearly that drinking water resources is considered as main factor for high level of Met-Hb. A significant positive relationship exists between the high level of Met-Hb and the tap water, reservoir or private wells water rather than treated or filtered water. In addition, there was a positive correlation between high level of Met-Hb and the boiled water.

The study revealed that nitrate was more prevalent in Khanyounis, Jabalia and Gaza which directly proportional with increased level of Met-Hb. Demonstrate that nitrate constitutes the main risk factor for increasing Met-Hb level amongst infants. The study findings indicate the importance of exclusive breast feeding for infants less than 6 months of age, and the choice a suitable source of water for these infant's use.

## Chapter 6

# CONCLUSION

A number of factors have been associated with high Met-Hb level in infants' blood; the major conclusion is reached from the results that the concentration of nitrate in the water of drinking water wells of the study area was over 150ppm, this means that the average concentration of nitrate in the drinking water wells of Gaza is more than the water quality standard for human consumption which have been set by WHO (50 ppm), and Palestinian standard (70 ppm). In addition it has been noticed strongly relationship between the Met-Hb level in blood of infants and the study area.

On the other hand there was high significant positive association between the age of infants and Met-Hb level in their blood; this proved that the use of water in feeding and nutrition of infants increases the possibility of increasing Met-Hb level in the blood of infants.

Regarding the ecological factors such as the drinking water resources, it is found that there a high significant association between Met-Hb level and water supply, where the high Met-Hb level was more prominent among infants of families were using tap water and water from other resources rather than treated and filtered water.

Moreover the finding reflects that the families of Khanyounis and Jabalia were using tap water more than that of Gaza. All these findings prove and ensure that the water is the main and essential factor which determines the level of Met-Hb in infant's blood.

In this regards it is important to mention that there was no significant correlation between most of socio-economic factors and Met-Hb level in infants' blood. There were no relationship between maternal age, educational level, occupation, paternal



educational level and occupation and family size from one side and the Met-Hb level in the other side.

Concerning the nutritional conditions of infants, there was significant negative association between exclusive breast feeding and Met-Hb level in infants blood, where the breast feeding was a protective factor for infants from getting high level of Met-Hb; where the using of formula and mixed feeding were a risk factor associated with high Met-Hb level of infants.

Furthermore the using of boiled water in preparation of formula or supplementation foods was a risk factor associated with high Met-Hb level. Also there was significant positive association between high Met-Hb level in blood and supplementation food.

There were no relationship between infants' health conditions and Met-Hb level, but there was significant positive association between high level of Met-Hb level and diarrhea, where diarrhea was more prominent among infants of high Met-Hb level. The most important finding was that there were high significant association between anemia and under weight from one side and high Met-Hb level from other side, where anemic and underweight infants were more of high Met-Hb level. This proves that the high Met-Hb level affects the GI tract condition of infants and so that affects the health status which depend on the nutrition of infants such as Hb level and the growth of infants where the average of Met-Hb level was high among retarded growth infants than among normal growth infants.

From the previous results, the most essential finding clearly that the main and essential factor which determines the level of Met-Hb in infants' blood is the quality of drinking water regarding nitrate concentration. The other essential finding that the most impact of Met-Hb level in health conditions of infants is that Met-Hb has negative impact on GI tract, Hb level, the growth and the weight gaining of infants.

## RECOMMENDATIONS



1. Enhancing the exclusive breast feeding among the infants' mothers in the first 6 months of age as a protective factor of methemoglobinemia;
2. Increase the awareness of Health care professionals and the public about the potential clinical manifestations and complications associated with elevated nitrate levels in drinking water;
3. Increase awareness of the public about the impact of using tap water, private well's water or reservoirs water on infants;
4. Allocating funds for improving laboratory routine diagnosis of Met-Hb, e.g. testing Met-Hb by Oximetry or alternatives in MOH;
5. Further studies are required to evaluate the quality of municipality drinking water at home in Gaza Strip and West Bank;
6. Conduct a national survey for determines the level of methemoglobin in infants' blood;
7. Implementing a national program aiming for complete treatment of drinking water resources; and
8. Establishing an epidemiological surveillance program to detect any new cases of methemoglobinemia for investigation and intervention.