



HEALTH SCIENCES

# HUMAN HEALTH RISK ASSESSMENT AND MANAGEMENT OF INDIAN POPULATION: AN *IN-SILICO* APPROACH

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## Abstract

Human health risk assessment and management (HHRAM) is a systemic approach to characterize the nature and concentration of human health risks associated with any health hazard and the possible restoration of health by utilizing the scientific and technological knowledge. Computer simulated work has been backbone in European countries for developing such approaches. Since not any synchronized HHRAM tool addressing to Indian population was available hence an in-silico approach allied to Indian circumstances was needed and so attempted to develop in present investigation. The study was completed in three phases: (1) HRA Questionnaire based data collection (2) Development of database and Database management system holding the data surveyed (3) Design and development of website uploaded with developed tool for risk communication and online health risk assessment & management. It is capable to reduce the health risks by identifying and characterizing the environmental, occupational and socio-economical health hazards exposing to human beings. The tool was developed with the help of advance computer software and programming languages viz. MySQL, Microsoft office 2007, Hypertext Preprocessor (PHP) and Cascading Style Sheets (CSS). Bio-calculators were also developed for statistical analysis of the data. Later the entire work was communicated worldwide through developed website named [www.healthrisk.co.in](http://www.healthrisk.co.in) for risk communication.

**Keywords:** HHRAM, In-silico tool, Database Management System, Bio-calculators, [www.healthrisk.co.in](http://www.healthrisk.co.in)

## Introduction

"Health is wealth", which depends on the interaction of various biotic and abiotic factors at individual, family, community, national and international level. Range of occupation, environmental factors, lifestyle, economical strength and standard education, etc. contribute to way of living life and eventually control the health (2). Today, with rapid technological advancement and strong scientific background at each level, one can achieve comfortable life. However, these conveniences and comfort may lead their own side effects in terms of low, moderate to severe health hazards' exposure to environment and human beings. Furthermore, behaviors such as lack of exercise, smoking, poor diet, non-prescribed medication, extended working hours and carelessness about health are among the factors that increase a person's risk of getting sick or dying prematurely. India, being a mosaic of pluralistic socioeconomic, environmental and occupational diversity may not be an exception. Various occupational health troubles is to be tackled along with existing socio-economical and environmental public health problems like communicable disease, malnutrition, poor

environmental sanitation and inadequate medical care (1). However, general knowledge of these risks does not always change behavior, and people don't necessarily know which of their risks needs the most attention.

Many efforts in the shape of health risk assessment and risk management and risk communication are done in western countries for their own population. As a consequence, various databases cited in the websites of Medline, EPA, CSA and NIH etc. are around. They are used as a tool for systematically analyzing, applying, and communicating complex and diverse information on risks to human health posed by exposure to environmental contaminants or circumstances (4, 5).

## Human Health Risk Assessment and Management (HHRAM)

Human health risk assessment is an organized process of describing and estimating the likelihood of adverse health outcomes from environmental hazards' exposures to human beings (3). It consists of four steps (I) hazard identification (II) exposure assessment (III) dose-response assessment and (IV) risk characterization" (7). The risk management is possible

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restoration of health by utilizing scientific and technical knowledge.

Nevertheless, HHRAM use has become more widespread in European countries with advancing sophistication of health risk estimation methods. On the contrary, constant growth and extensive use of health risk data has raised the complication into its collection and retrieval. To lessen the distress various Database (DB) and Database Management systems (DBMS) have been and are being developed across the globe to logically collect and interrelate the information in computerized format. They can produce rapid & accurate outcomes with absolute efficacy in a cost effective manner. Since, the Indian circumstances are different from Europeans in many ways so the DBs and DBMSs developed in European countries are found incompatible while such approaches addressing to Indian population are almost nil.

So a HHRAM approach for quantitative risk assessment and management of Indian population and to develop more efficient strategies for prioritizing health hazard was attempted to develop in the present investigation.

## Material and Methods

The investigation was completed in four phases:

### First phase

Existing health risk information, available on websites, case studies and hospital records were roamed for significant data collection of both rural and urban Indian population.

### Second phase

A health risk assessment questionnaire containing variables of our interest related to environmental, occupational and socio-economical health status was designed and developed in English and Hindi as well. Questionnaire based health survey of rural and urban population of Uttar Pradesh was started initially.

Online questionnaire form was developed containing nearly same variables as previous one followed by its uploading on internet for online surveys. As it may get quicker and richer open-ended response than offline surveys (8).

*Sample selection:* Individual with environmental, socio-economical and occupational variability were under spot light during offline survey.

### Third phase

The DBMS was developed on a Pentium®-4CPU, 3.20 GHz personal computer with 80 GB of memory. The system was supported with Intel 4 processor having windows XP professional service pack-2, version- 2002. The application software used for system development was Microsoft DOT NET version 3.5 and MySQL (6). Modular programming (MP) was used to simplify programming and flexibility in data processing. Additionally, Macromedia Dreamweaver for outlook designing, SPSS and C++ language for data calculation were used.

Database and Database Management System (DBMS) was developed to logically collect and retrieve the collected data as and when required. Bio-calculators were developed using C++ computer language to analyze the stored data. Moreover, oxidative stress and xenobiotic markers related enzymatic calculations may also be done. Few more calculators related to food technology are in pipeline.

### Fourth Phase:

A website ([www.healthrisk.co.in](http://www.healthrisk.co.in)) uploaded with entire tool and other health related information was designed and developed for wider applicability of the tool as an online HHRAM approach. The tool was developed in a way where data analysis of every individual was done with the help of developed bio-calculators and the health status inferences were produced in form of risk report to every end user.


## Results

### Human Health Risk Assessment Questionnaire

The HRAQ was made up of total 58 questions divided in four major sections of Personal history, Environmental status, occupational health status (clinical history, disease history) and socio-economic status. Smaller size, respondent interest and Indian scenario was taken care during its development so that it could retrieve complete and required information of volunteer.

Since, Hindi is mother language of India and spoken in its largest area so, in order to comprehension of questionnaire it was translated in Hindi in second phase of study.

Figure-1: HRAQ (English)

 Form No.: Questionnaire on Human Health Risk-Assessment

**NOTE :** For Yes/No Please Tick in the box

**SECTION -'A'**  
PERSONAL HISTORY


CODE

- Today's date : Date    Month    Year
- What is your age?  in years  
Birth date? Date    Month    Year     Place of Birth  Distt. & state
- Residence  
Present Full address  Duration  Permanent Full address  Duration
- Sex M  F
- Ethnic group? Indian  Other than Indian
- Educational Background  
Qualification  Nature of Qualification  Remarks   
Academic     
Technical     
Professional
- Your religion?  
Hindu  Muslim  Sikh  Christian  Others
- Marital status?  
Married  Unmarried  Divorced   
Widowed  Married twice  Separated
- Children:  
Own  Adapted  Number  Male   
Female

**Pedigree**

- Type of Family: Nuclear  Joint
- Total number of family members Adults  Male  Female  Children  Total
- Income: Person's Income  Total family income  Total earning members  Per capita income

Figure-2: HRAQ (Hindi)

 मानव स्वास्थ्य जोखिम मूल्यांकन प्रश्नमाला

नोट : कृपया उचित खाने में सही (✓) का निशान लगायें।

**भाग 'ए'**  
व्यक्तिगत ब्योरा

- आज की तारीख : तिथि    माह    वर्ष
- आपकी उम्र क्या है?  वर्ष में  
जन्मतिथि : दिन    माह    वर्ष     जन्म स्थान  जिला व राज्य
- घर का पता  
वर्तमान पूरा पता  कबसे रह रहे  स्थायी पता  कब से रह रहे
- लिंग : पुरुष  स्त्री
- राष्ट्रीयता : भारतीय  अन्य
- शैक्षिक परिप्रेक्ष्य  
शिक्षा  विषय  अन्य   
शैक्षिक     
तकनीकी     
रोजगारपरक
- आपका धर्म : हिन्दू  मुस्लिम  सिक्ख  इसाई  अन्य
- वैवाहिक स्थिति  
शादीशुदा  अविवाहित  तलाकशुदा   
पति/पत्नी की मृत्यु  दोबारा शादी  अलग-2 रह रहे हैं
- बच्चे : अपने  गोद लिये  आयु  संख्या  स्त्री   
पुरुष

**पारिवारिक विवरण**

- परिवार का प्रकार : केन्द्रित  संयुक्त

### Database and Database Management System (DBMS) for HHRAM

Developed DBMS was uploaded on website with the following features:

- Health Assessment tool
- Health Calculators for Risk Assessment
- Search facilities on the basis of permutation with more than two fields simultaneously
- Up gradation from User's end
- Health tips
- Auto Broadcast for Health Risk

- General information (Events, Training, Conferences, Publications, Links etc.)

Total sample size of 2000 individuals' data was collected and included in the database **at the time of data compilation for this paper**. Because the finding details of every assessment were need to be reported in a clear and logical manner. Therefore risk report containing inferences on health status of individual was generated and presented to every end user.

Figure-3: Number of volunteers surveyed from different locations

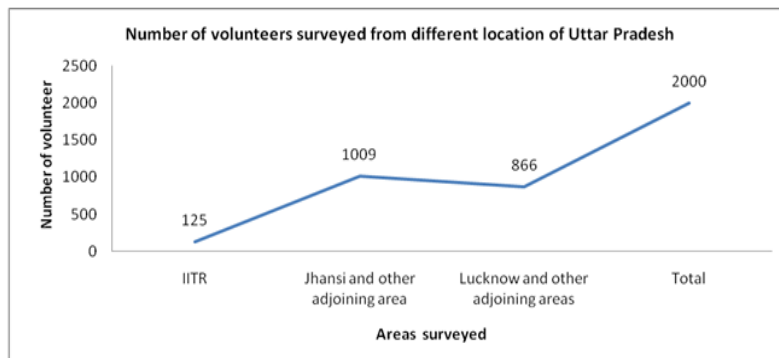
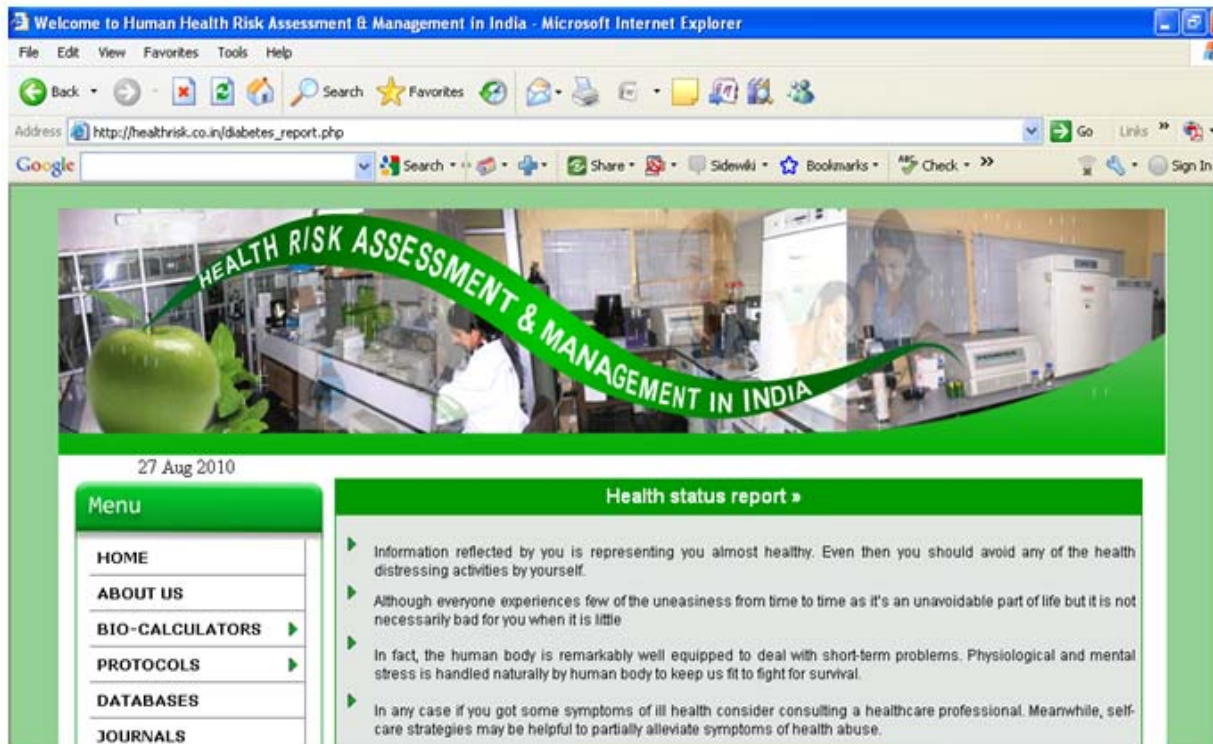


Figure-4: A risk report generated for a healthy volunteer



## Discussion

The HRA questionnaire was better used to collect wider array of individual's health risk information. It may also be used by other regulatory agencies too while planning for HHRAM and/or epidemiological study in India. The collected information may play pivotal role into understanding the attitudes and preferences of individual and groups towards their health and healthcare. The questionnaire is supposed to draw on varied research methods in predictive, evaluative and behavioral sciences to discover new ways to help people maximize their health.

Developed "*Biocalculators*" may be used frequently in task ranging from laboratory research workers to college students or simply for statistical purposes. Significant potentiality of the developed calculators could be demonstrated in establishing the possible correlation between human health risk assessment and factor associated.

The developed *In-silico* tool might be useful to assess the potential health effects of various health hazards' exposure that lack experimental toxicity data.

The risk report and educational message crafted as per analysis of the information provided from user's end is the final culmination of every assessment. Although, they may be useful into predicting the health risk of volunteers to make them aware yet they reinforce the importance of adhering to treatment plans and medication. These are meaningful reports on 'well/at risk' population, allowing for better strategic planning and trend identification for better health outcomes and cost saving. They may be valuable for targeting wellness programmes and incentive strategies. Whatever essential and affordable suggestions are proposed may be very effective if applied deliberately. Users' feedback may importantly advise the needed modification in the system to make it more task oriented. As health risk assessment is itself a dynamic field of research and changes adjustment is a fundamental need of its success.

## Benefits to the Society

The tool may extensively serve for risk identification, its characterization and management. Human health survey of human population living in any particular Indian locality may be taken for designing the HHRAM, epidemiological and other relevant studies in future. Not only, researcher even students, private sectors, scientists, various regulatory agencies (state/provincial/national/international) would be likely to take the revenue of it.

## Conclusion

Though, in the present investigation efforts are afoot to develop an umbrella approach for HHRAM of Indian population and to provide other health information due to accidental nature of exposure, it changes considerably which is tough to cover in only one approach. Since, new developments, new science and new information will continue to impact on our health so few more approaches are required to develop at larger scale which can specifically and effectively evaluate and manage the health risks of Indians.

## Conflict of interest

Author(s) declare no conflict of interest.

## Reference

1. Habibullah N Saiyed and Rajnarayan R Tiwari. 2004. Occupational Health Research in India, *Industrial Health*, **42**: 141-148
2. Ramesh V Bhat. 2008. Human health problems associated with current agricultural food production, *Asia Pac J Clin Nutr*, **17**(S1):91-94
3. U.S. Presidential/Congressional Commission on Risk Assessment and Risk Management 1997. Framework for environmental health risk management. Final Report, **1 & 2**. Washington, DC.
4. Hrudehy, S. E. 1998. Quantitative cancer risk assessment—Pitfalls and progress. *Iss. Environ. Sci. Technol.* **9**:57-90.
5. Cindy G. Jardine, Steve E. Hrudehy, John H. Shortreed, Lorraine Craig, Daniel Krewski, Chris Furgal, Stephen McColl. 2003. Risk Management Frameworks for Human Health and Environmental Risks, *J. of Toxicology and Environmental Health, Part B*. **6**: 569-641
6. P.M. Forristal, D.L. Wilke, L.S. McCarty. 2008. Improving the quality of risk assessments in Canada using a principle-based approach, *Regulatory Toxicology and Pharmacology*, **50** (3): 336-344
7. U.S. National Research Council. 1983. Risk assessment in the federal government: Managing the process. Washington, DC: National Research Council, National Academy of Sciences, National Academy Press.
8. Barrie Gunter, David Nicholas, Paul Huntington, Peter Williams. 2002. Online versus offline research: implications for evaluating digital media, *Aslib Proceedings*, **5** (4): 229-239