Database Management System for Prediction and Management of Occupational Health Hazards

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Abstract: *The new paradigm envisioned for epidemiological studies in 21st century advocates shifting from the current survey based protocols to combination of evidence based laboratory/ clinical studies coupled with in silico approaches. One among the key strategies is to adopt an integrated approach, which can acquire, analyze, and interpret the data both qualitative and quantitatively in one go. But, this challenging task has highly hampered due to complexity of human physiological systems, ethical dubious, etc. Thus, the present investigations were aimed to develop an interactive online tool for prediction and management of human health for Indian population engaged in different occupation. At first step, a comprehensive questionnaire on human health risk assessment and management was developed and used for offline data collection. Simultaneously, a database management system (DBMS) was developed using software and programming languages mainly including MySQL, MS Office 2007, Hypertext Preprocessor (PHP), Cascading Style Sheets (CSS), Macromedia Dreamweaver, SPSS, java script, C++ language, Microsoft DOT NET, etc. For the purpose, the DBMS was developed and is being used through website "www.healthriskindia.in" for online survey. Upon the analysis of data collected from 2000 individuals of Jhansi and Lucknow districts of Uttar Pradesh, the socioeconomic status, education, hygiene status, occupation type, etc. were found to be associated with proneness to the diseases. Further, the relation between health status and day to day activities of the individuals engaged in different occupations of different groups in the society was analyzed successfully using DBMS. The analysis made in different combination of permutation using the data of 2000 volunteers show significant simulation with epidemiological data generated through conventional means for the mimicking population residing in the study area.*

Key Words: *In silico,* DBMS, Health, Risk

Introduction

Now-a-days the World Wide Web (WWW) has become an important resource of 24 hour-a-day access to information needed by human health risk assessors. Different web sites and other internet resources which were holding the comprehensive databases could present comprehensive information needed for human hazard identification, dose–response evaluation, exposure assessment, risk characterization, risk management and risk communication (Dieter and Hakkinen, 2004). Extensive collection of data on risk assessment were found in sites sponsored by Risk World, the US EPA's National Center for Environmental Assessment (NCEA), the US National Library of Medicine's TOXNET (Fonger *et al*., 2000), the US Agency for Toxic Substances and Disease Registry (ATSDR, 2011), and the International Programme on Chemical Safety (IPCS) (WHO, 2011). Numbers of Database Management System are available on Internet offering following accesses to exposure assessment information were reviewed during the study.

- ? US Agency for Toxic Substances and Disease Registry (ATSDR)
- ? US Alliance for Chemical Awareness (ACA)
- ? European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)
- ? European Commission: European Chemicals Bureau (ECB)

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- ? Environmental Defense (ED)
- International Programme on Chemical Safety (IPCS)
- International Society of Exposure Analysis (ISEA)
- Organisation for Economic Co-operation and Development (OECD)
- RiskWorld
- Society for Risk Analysis (SRA)
- US EPA's Exposure Assessment Tools and Models Web Site
- US EPA National Center for Exposure Assessment's (NCEA) Exposure Factors Program
- US EPA's Guidelines for Exposure Assessment
- US EPA's Toxics Release Inventory (TRI) Web site

The physical and chemical properties of toxicants, the environmental fate and transport, government regulations, guidance, training for performing risk assessments and other valuable information are present on various websites (Patterson *et al.*, 2002). Several professional societies and other organizations have web sites addressing risk assessment issues and information, and there are Internet mailing lists for online help and for sharing information and perspectives.

The Database Management System (DBMS) via Internet is available on the official website of US Environmental Protection Agency. (http://www.epa.gov/superfund/ programs risk/toolthh.htm).

Most of the databases reviewed are well categorized and developed to minimize the risk level in western countries. Some of them were upgraded regularly to assess and manage the risk successfully. As Indian circumstances are entirely different from the European countries thus whatever health risk databases are available are not fit for Indian scenario. In India the living and work style is entirely different and unique in various ways. Though few of the databases on health risk assessment were found for Indian population but they seem haphazard and have not landed with any firm conclusion. Health risk assessment is due to the occupational hazards is an emerging science. Thus, in the present study attempts were made to develop a functional Database Management Assessment for the population of Lucknow, Jhansi and other adjoining areas initially. Concept of study was simply based on assessment of information provided by the user/respondent/volunteer and to suggest them mitigations (in form of few adorable changes in their life style, and living standard) to manage the risks at minimum acceptable level.

Materials and Methods

In the present study, efforts have been made to design and develop Database Management System (DBMS) for human health risk assessment engaged in different occupations to address the health hazards generated and existing in an Indian scenario, so as to advise valuable mitigations to reduce the risk to a minimum acceptable level. Entire process was made possible by the initial information provided by human volunteers.

We designed and developed a comprehensive questionnaire for the assessment of human health risk assessment. Besides the hard copy, the questionnaire was also designed and uploaded on the desktop and hooked up with a database for the automatic/manual or online/offline development of data bank. Initially, a survey of employees of Indian Institute of Toxicology Research (IITR), Lucknow, was conducted using the said questionnaire among the scientists and other staff. The computation of the records was done for the formation of baseline data.

To develop a DBMS for Human Health Risk Assessment System (HHRAS) due to the occupational health, over 2000 volunteers' data were collected during the study. Addition to that, data of over 200 volunteers were also included through online survey. Since online survey is a continuous process leading to an increase the number of volunteers in the database, still data is being collected via the Online Ques-tionnaire uploaded on the website : www.healthriskindia.in

The database was designed and developed by using software Structured Query Language (SQL) for creating, managing and updating the database in the background. In front end, the website was designed with the help of the software Macromedia Dreamweaver, Photoshop and Flash so that the users can use the designed and developed system.

There are lots of factors at the side of client's environment engaged in different occupation that restrict the choice of designer. The factors and standards which were best tried to follow are resource limits, operating environments, reliability and security requirement and policies that may have an impact on the designing the DBMS for occupational health hazards were kept in mind.

Results and Discussion

The detailed analysis of the volunteers concerned with different types of occupation was made. Further, their comparison with different groups was also made to assess their health status. Out of total 2000 surveyed volunteers, 1342 were employed and remaining 658 volunteers have told that they were not engaged with any type of service (Fig. 1). The volunteers engaged in gainful occupation were considered employed and vice versa were calculated under unemployed ones. In further health status analysis of the employed volunteers, 758 volunteers were found higher than the healthy ones (584) (Fig. 1). In the next step of analysis total employed volunteers were bifurcated into office workers (511) and field workers (498) (Fig. 2) for estimating their health behavior. The people like Scientists, Teachers, Bank employees, Data Entry Operators and others like them were kept in the category of office workers. While the respondents like Rickshaw pullers, Traffic policemen, Auto drivers, vegetable and fruit shopkeepers and other related ones were kept in the category of field workers. The division was made on the basis of environmental exposure they face as per the nature of their work. Further, in comparative health status analysis of them field

workers were found unhealthier than the office workers (Fig. 2). At one side where the number of unhealthy volunteers among the field workers was 253 than 245 healthy ones, it was 166 unhealthy than 345 healthy individuals among the office workers (Fig. 2).

At next stage when the health status analysis of different types of office workers (types considered are given above) was done, the number of healthy volunteers were observed significantly decreasing when moving from Teachers to Bank employees and Data entry Operators (Fig. 3). The highest percentage of unhealthy volunteers (52%) was observed among the data entry operators (Fig. 3). Large number of unhealthy volunteers (41) than healthy ones (81) among the scientists was also observed (Fig. 3).

In the health status analysis of different types of field workers (types considered are given above) the highest percentage of unhealthy volunteers (nearly 55%) was observed among the Auto drivers (Fig. 4). Collectively, the number of unhealthy volunteers was found always higher than the healthy volunteers moving from Rickshaw pullers (82 unhealthy than 43 healthy) to Auto drivers (94 unhealthy than 78 healthy) and Traffic policemen (60
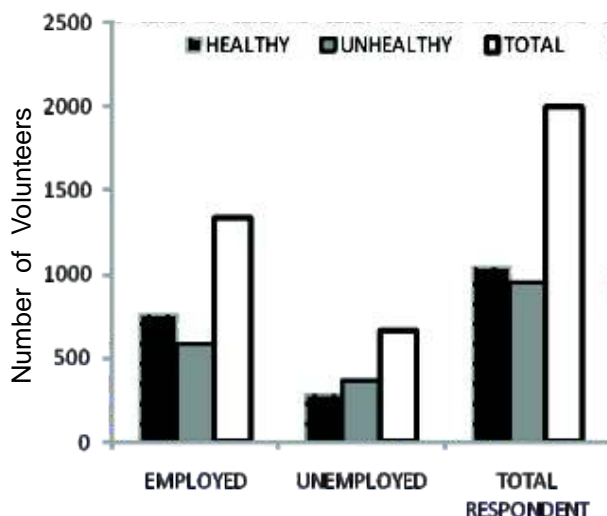

Fig. 1. Showing Comparative Health Status of the Employed and Unemployed Volunteers

Fig. 2. Showing Comparative Health Status of the Volunteers involved in different types of Employment
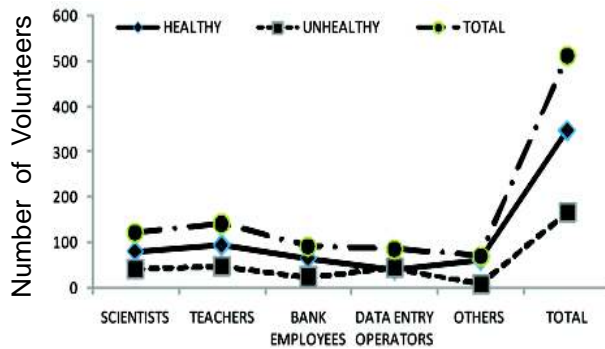

Fig. 3. Showing Comparative Health Status of the different types of Office Workers Surveyed during the Study
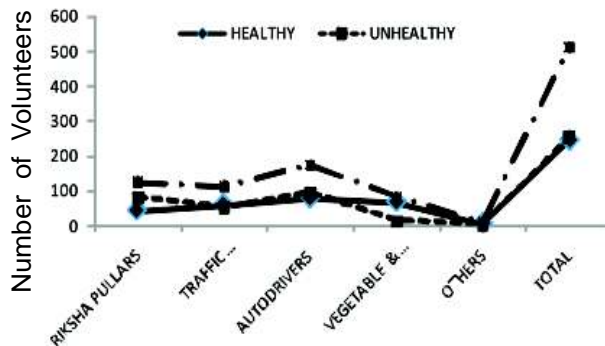

Fig. 4. Showing Comparative Health Status of the different types of Field Workers Surveyed during the Study

unhealthy than 52 healthy) while it dropped down among the vegetable and fruit shop keepers (14 unhealthy than 67 healthy) (Fig. 4).Observations have clearly indicated the relation of exposing occupation with the ill health behaviors.

In further analysis, human body systems related health disorders were assessed. Total nine standard body systems (included in the questionnaire) were considered for analysis of health status of both employed and unemployed volunteers. The systems considered were Sensory system, Cardio-vascular system, Teeth & Gums, Gastro-intestinal system, Musculo-skeletal system, Nervous system, Genito-urinary system, Respiratory system and skin. Among employed unhealthy volunteers (584) highest 110 volunteers were found suffering from Sensory system related health disorders. In addition to that Cardio-vascular system sufferer (93), Nervous system sufferer (76) and Respiratory system sufferer (95) were also considerably higher (Fig. 5).
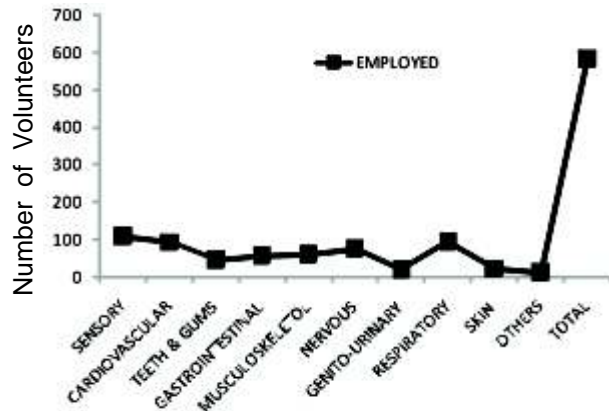

Fig. 5. Showing Employed Volunteers Suffering from various Body System Health Related Disorders
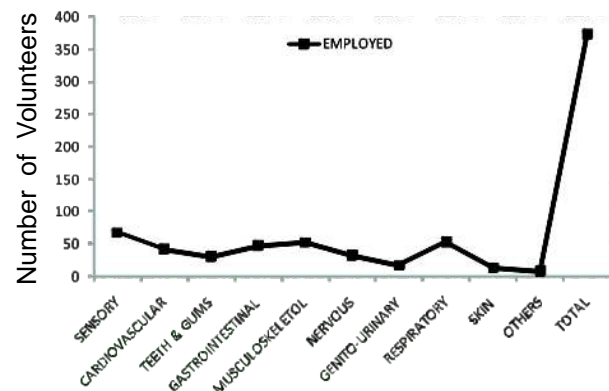

Fig. 6. Showing Unemployed Volunteers Suffering from various Body System Health Related Disorders

The assessment done amongst unemployed volunteer is shown in Fig. 6. Out of 373 unhealthy volunteers highest 67 volunteers were found suffering from Sensory system related health disorders. 42 cardiovascular system related sufferer, 47 gastrointestinal system related sufferer, 52 Musculo-skeletal systems related sufferer and 53 respiratory system related sufferer were followed to highest. Almost similar systems were found involved in health disorders among employed and unemployed as well except Nervous system in employed volunteers only (Figs. 5-6). A considerable hike in the nervous system sufferer was observed in employed volunteers (Figs. 5-6).

In the next step, comparative health disorder analysis related with various body systems was done among the employed and unemployed unhealthy volunteers (Fig. 7). Consequently, number of unhealthy volunteers among unemployed ones was observed considerably higher in almost all types of body systems related disorder. Highest difference between employed and unemployed sufferer was observed in Respiratory system (52 Volunteers) and Cardio-vascular system (51 Volunteers) related health disorders (Fig. 7). Though the difference was significant in Sensory (43) and Nervous system (43) related health problems too (Fig. 7). The difference of 211 volunteers' was found between the unhealthy employed and unemployed ones, has undoubtedly indicated the adverse health effects of occupational exposure to the health. Out of them Sensory, CVS, Nervous and Respiratory system related disorders were found prominently (Fig. 7).

Moving to further, the comparative health assessments between employed and unemployed volunteers were done taking one by one system observed prominently concerned with health related disorder in the previous step. At first the comparative assessment was executed in the sensory system related health disorders involving employed and unemployed volunteers. Total six disorders recurrent in the surveyed population and questioned in the questionnaire were considered for the assessment. Those were Farsightedness, Nearsightedness, Blinking and watery eye, hard hearing, Noisy ears and other problems related with system considered. Highest 63 cases were observed suffering from nearsightedness (Fig. 8). Cases of farsightedness (42) were followed to the highest. In the comparison, cases of employed sufferer at nearly every considered disorder was found higher than unemployed ones except one, blinking and watering of eye (13 in comparison to 11 in employed ones (Fig. 4.19). Collectively cases in employed volunteer (110) were observed higher than the cases found in unemployed ones (67) (Fig. 8). Results have indicated more eye related problems
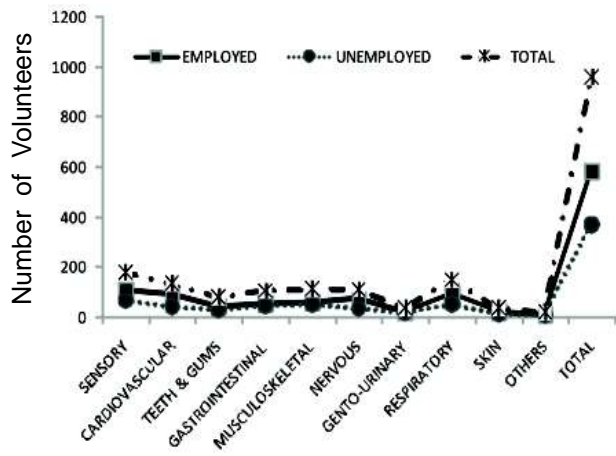

Fig. 7. Showing Comparative Detail of Volunteers (Employed & Unemployed Both) Suffering from various Body System Health Related Disorders
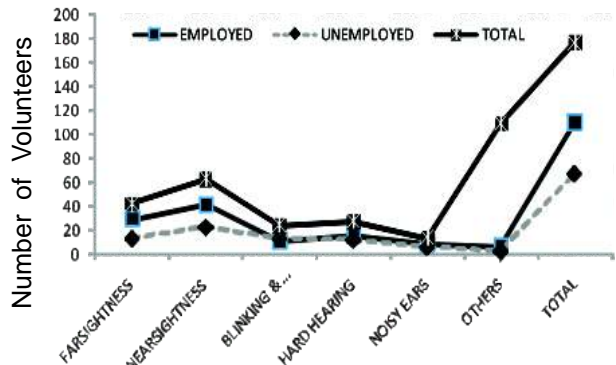

Fig. 8. Showing Comparative Detail of Volunteers (Employed & Unemployed Both) Suffering from various Sensory System Related Health Disorders
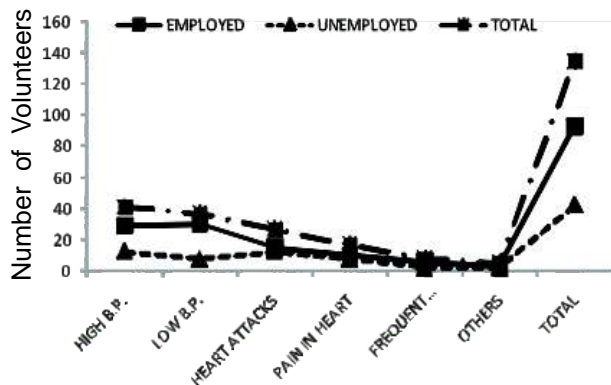
Fig. 9. Showing Comparative Detail of Volunteers (Employed & Unemployed Both) Suffering from Cardio-vascular Systems Related Health Disorders
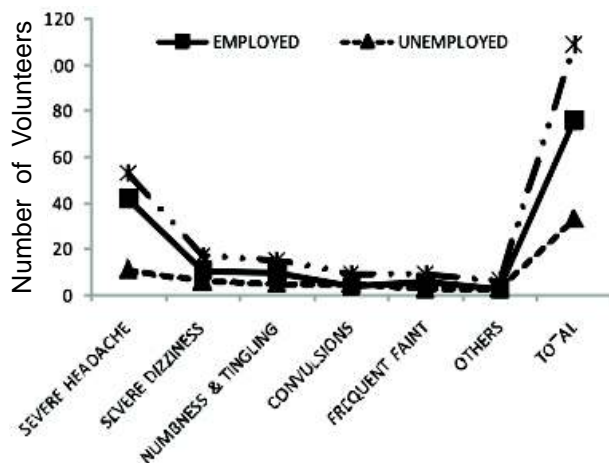

Fig. 10. Showing Comparative Detail of Volunteers (Employed & Unemployed Both) Suffering from Nervous System Related Health Disorders

among the people engaged in occupation especially like computer working.

At second level, Cardio-vascular system related problems were considered and the comparison was made in the similar way as earlier. Out of 135 volunteers (employed & unemployed) suffering from the CVS related disorders, 93 was employed individuals in comparison to 42 unemployed one (Fig. 9). Total six disorders largely observed in the selected population and questioned in the questionnaire were considered for comparison. Those were High Blood Pressure, Low Blood Pressure, Heart attacks, Heart (chest) pain, frequent palpitation (abnormal heart beats) and other disorders related with the system. Similar to sensory

system more number of employed volunteers was observed suffering from the considered disorders (Fig. 9). Out of highest 37 cases of Low B.P. 30 were among the employed volunteers. Similarly number of high B.P. cases was also found higher in employed (29 cases) than unemployed ones (12) (Fig. 9). Likewise the cases of heart attacks (15/12), chest pain (10/7) and palpitation (6/2) were higher in employed than unemployed volunteers (Fig. 9). More heart related problems among employed than unemployed ones have suggested the bad effects of occupational health exposure on the CVS of them.

At third level, disorders related with Nervous system were taken to make comparison between employed and unemployed ones. Similar to previous step six prominent disorders questioned in the questionnaire related with the Nervous system were considered for assessment. Those were severe Headache, severe Dizziness, Numbness & Tingling, Convulsions, frequent faint and other problems related with the Nervous system. Out of total 109 cases 76 than 33 were found among the employed and unemployed volunteers respectively (Fig. 10). Highest 53 cases of severe headache were observed among the both which was included with 42 cases of employed and 11 of unemployed volunteers (Fig. 10). Likewise the cases of severe dizziness, numbness & tingling and frequent faints were observed higher among the employed individuals though the cases were more striking in severe headaches, only.

At last, the problems related with Respiratory system were considered for making comparison. Unlike the above total seven disorders of respiratory system frequent in the selected population and questioned in the questionnaire were measured for comparison. Those disorders were Cough, Wheezing, Sputum, Breathlessness, pain in chest, Nasal catarrh, Cold and other respiratory system related problems. Among 148 relevant cases total 95 in comparison to 53 were found in employed and unemployed volunteers

respectively (Fig. 11). Highest 38 cases of cold were followed by 33 cases of chest pain and 27 of breathlessness (Fig. 11). 28 out of 38 cases of cold were reported in employed individuals. Likewise 20 out of 27 and 22 out of 33 were found among the employed volunteers (Fig. 11). Thus, the problems were found more concerning with employed volunteers than unemployed ones. In almost all selected systems' disorders cases amongst employed volunteers were observed higher than unemployed ones.
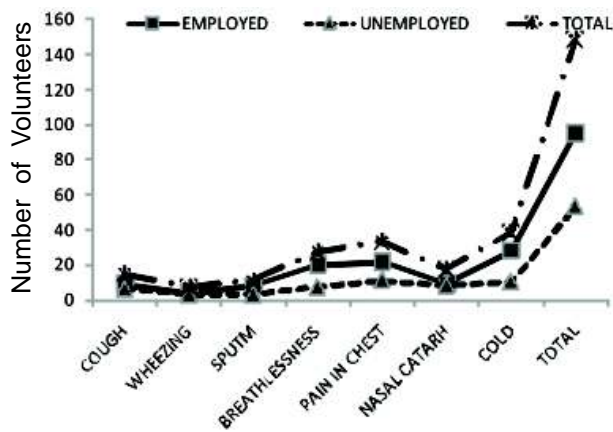

Fig. 11. Showing Comparative Detail of Volunteers (Employeed & Unemployeed Both) Suffering from Various Body System Health Related Disorders

Observations of increased health illness among employed volunteers indicates the deleterious effect of the occupational exposure on normal health behavior (Stone *and* Godleski, 1999). Results of this study are clearly suggesting the work related side effect on the normal functioning of various body systems viz. Nervous system (Joode *et al.,* 2001; Juntunen *et al.,* 2009), sensory system (Juntunen *et al.,* 2009), Cardio-vascular system (Hoek *et al.,* 2001; Hong *et al.,* 2002; Pope *et al.,* 2004; Kjell *et al.,* 2007), Respiratory system (Ingle *et al.,* 2005; Jones and Killan, 2008). Person works before computer in offices for more than eight continuous hours may be suffering with the eye (Wijers *et al.,* 1999) and heart related problems (Kjell *et al.,* 2007) due to long time continuous exposure of the computer radiations. Scientists expose with the numerous fumigants and toxic

chemicals (Wegman *et al.,* 1995) during their lifetime performing various experimental researches and thus various health related disorders get developed among them. Studies have supported the various nervous system related disorder like severe headache (Junko *et al.,* 1996), severe dizziness, frequent faints (Juntunen *et al.,* 2009) *etc.,* cardio-vascular system related disorders like abnormal blood pressure (Pope *et al.,* 2004), palpitation and deaths from heart attacks and respiratory system related disorders like asthma (Roel *et al.,* 2002; Rosenstock *et al.,* 1990), Tuberculosis (Seidler et al., 2005; Garber *et al.,* 2003), pneumoconiosis (Roel *et al.,* 2002), breathlessness (Sunyer *et al.,* 1998) etc. among the subjects engaged with different type of occupation. Occupational asthma has become increasingly recognized as occupation induced disorder (Davison *et al.,* 1983; Zock et al., 2001). In developing countries like India, however, the traditional occupational lung diseases of silicosis, pneumoconiosis, and asbestosis remain common in rapidly industrializing areas (Kusaka *et al.,* 1986). In contrast the subjects not engaged in any fixed type of occupation and relaxed from latent exposure of lethal health hazard were observed comparatively healthy then employed one which is suggesting evidence for work related malignancies.

System operation and Validation

The system developed which could perform integrative analysis of database files along with flexibility in their data. The results showed in this paper are on the basis of the data collected offline/online (initially Lucknow and adjoining areas) through the comprehensive questionnaire designed and developed has been checked and matched with the analysis done through the DBMS designed and developed specially for those who are engaged in different type of occupations. The results obtained on the basis of manual statistical analysis (data collected offline) have been matched with the results found through the designed and developed System discussed in

the present research paper were the same and matched totally.

The validation was checked through a black-box test that meets the requirements, works as expected and is being implemented. The analysis made in different combination of permutation using the data of volunteers showed significant simulation with epidemiological data generated through conventional means for the mimicking population residing in the study area. To use the designed and developed, Database Management System for Prediction and Management of Occupational Health Hazards, visit to the website – www.healthriskindia.in.

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