Introduction

Potable and safe water is normally defined as water that is free from pathogenic agents and chemical substances, pleasant to taste and usable for domestic purposes. Polluted water, the basic cause of most of the water borne diseases, is caused by human activities like rapid unplanned industrialization, urbanization, agricultural pollutants like pesticides and insecticides, wrong waste management in the urban areas etc.

The public health impact of water pollution is enormous. A number of diseases with high morbidity and mortality are wide spread in the communities specially living in unsuitable environmental conditions in urban slums areas. The major diseases that are attributed to environment pollution and contaminated drinking water supply are: diarrhoeal diseases, cholera, shigellosis, fluorosis, poliomyelitis, typhoid, dysentery, amoebiasis, giadiasis, malaria, skin diseases and water borne viral hepatitis.

The major living sites of urban poor in North Indore city are slums; squatters on pavements, besides railway tracks, water pipelines, under bridges, banks of city drains, marshlands and so on. These urban poor are also understood to be the biggest sufferer group of urban society and major victims of all types of environmental pollution and other epidemics due to their living in pathogen-prone neighbourhoods, with cramped conditions in shacks and limited access to basic civic services like safe and adequate water supply, sewerage and drainage, sanitary toilets, solid waste disposal facilities.

This study is aimed at presenting the linkage between living environmental conditions (in the context of urban water pollution and sanitation) and consequent public health implications as revealed after a comprehensive survey conducted during 2011-12 on selected wards of slums, squatters and pavement dwellers of North Indore city, India.
Materials and methods

Socio-ecological and health survey

To find out the causative factors on the human health a questionnaire have been prepared based on N.C.A.E.R. New Delhi. The data collected have been subjected to statistical analysis.

- Contour of the locality and its type.
- Locality of water sources.
- Localization and relationship of water sources and sewage tank.
- Condition of water sources (Hand pump) and their neighbourhoods.
- Common diseases of the areas.
- Water borne diseases in the areas.
- Medical facility available in the areas.
- Study of public latrine facility.
- Study of population density.

The data and information have been collected from the field survey by using questionnaires. Observation checklist was used to record the environment and sanitation conditions of the water sources, and settlement localities.

In the presents the sampling were randomly selected in North Indore city.

Results discussion

Contour of the Locality and its type

In the study area maximum wards were located on Plain (38.22%) followed by on unequal surface (33.33%), on hill and plain (17.92%) and on the hill/rock (10.52%). The wards have located on plaines were maximum in ward no. 39 (76.67%) followed by ward no. 13 and ward no. 16 (66.67% each) and ward no. 24 and ward no.
36 (60% each). They have been reported minimum in ward no. 42 (10%) followed by ward no. 21, ward no. 34 and ward no. 38 (16.67% each) and ward no. 13, ward no. 19 and ward no. 41 (20% each).

The wards which have placed on the hill/rock were maximum in ward no. 22, ward no. 34 and ward no. 42 (30% each) followed by ward no. 04 (23.33%) and ward no. 18 and ward no. 38 (20% each). They have been recorded lowest in ward no. 14, ward no. 20 and ward no. 25 (6.67%) followed by ward no. 17 and ward no. 41 (10% each) and ward no. 13 and ward no. 21 (13.33% each).

The wards which have placed on the unequal surface were recorded maximum in ward no. 21 (60%) followed by ward no. 30 (53.33%), ward no. 28 and ward no. 44 (50% each) and ward no. 26 (46.67%). They have been recorded minimum in ward no. 39 (10%) followed by ward no. 36 (13.33%), ward no. 24 (16.67%) and ward no. 17 and ward no. 37 (20% each).

The wards have placed on hill and plain were reported maximum in ward no. 20 (40%) followed by ward no. 17 (36.67%) and ward no. 41 and ward no. 34 (30% each). They have been reported lowest in ward no. 7, ward no. 16, ward no. 22, ward no. 28, ward no. 30 (6.67% each) followed by ward no. 21, ward no. 23, ward no. 29 and ward no. 44 (10% each) and ward no. 14, ward no. 25, ward no. 26, ward no. 33, ward no. 35 and ward no. 39 (13.33% each).

**Locality of drinking water sources**

In the study area maximum water sources were located at plaines (51.46%) followed by in hilly areas (21.98%), near of refuge dumps (16.46%), near of sewer line (8.02%) and near of garbage (2.08%). The water sources located on plaines maximum in wards were ward no. 39 (76.67%) followed by ward no. 15 (73.33%), ward no. 27 and ward no. 38 (70% each) and ward no. 24 and ward no. 36 (66.67% each). Least water sources located on plaines was found in ward no. 35 (23.33%) followed by ward no. 42 and ward no. 22 (30% each).
The water sources located on hilly areas were maximum in ward no. 18 (46.67%) followed by ward no. 25 (40%) and ward no. 42 and ward no. 07 (36.67% each). Least water sources located on hilly areas were recorded in ward no. 15, ward no. 36 and ward no. 38 (6.67% each) followed by ward no. 20, ward no. 27, ward no. 32 and ward no. 37 (10% each). Maximum water sources located near of garbage were recorded in ward no. 17 (23.33%). The minimum recorded in wards were ward no. 19, ward no. 35 and ward no. 42 (3.33% each) followed by ward no. 07, ward no. 14, ward no. 15, ward no. 32 and ward no. 34 (6.67% each).

In the present study maximum water sources located near the sewer line recorded in ward no. 34 (23.33%) followed by ward no. 35, ward no. 31 and ward no. 16 (16.67%). Least water sources located near sewer line noted in ward no. 39, ward no. 33 and ward no. 23 (3.33% each) followed by ward no. 38, ward no. 42, ward no. 37, ward no. 29, ward no. 26, ward no. 17 and ward no. 07 (6.67% each). Other wards in which more than 10% water sources located near sewer line recorded in ward no. 13, ward no. 14, ward no. 20, ward no. 21, ward no. 28, ward no. 15, ward no. 19, ward no. 22, ward no. 32 and ward no. 36. However in ward no. 04, ward no. 18, ward no. 24, ward no. 25, ward no. 27 ward no. 30 and ward no. 44 in which none of water sources were located near sewer line.

In the study areas the maximum 30 per cent of water sources were located near refuge dumps recorded in ward no. 35 followed by ward no. 31, ward no. 22 and ward no. 44 (26.67% each) and ward no. 32 (23.33%). Least water sources located near refuge dumps were recorded in ward no. 15 (3.33%) followed by ward no. 07, ward no. 26 and ward no. 39 (6.67 each) and ward no. 13, ward no. 16, ward no. 21 and ward no. 25 (10% each). In all other wards were more than 13.33 per cent of drinking water source located near the refuge dumps.
Localisation and Relationship of water sources with sewage tank

In the study area maximum available of water sources of tube well (54.69%) followed by tap water supply (44.37%), Hand pump (0.94%) and well water supply was not recorded in the survey report. The tube well water source was reported
maximum in ward no. 34 (73.33%) followed ward no. 17, ward no. 21 and ward no. 22 (70% each) and ward no. 20, ward no. 29 and ward no. 41 (66.67% each). Least of the tube well water source was reported in ward no. 18 (36.67%) followed ward no. 04, ward no. 13 and ward no. 32 (40% each) and ward no. 26, ward no. 27 and ward no. 44 (43.33% each). The tap water supply were maximum in ward no. 13 and ward no. 32 (60% each) followed by ward no. 26, ward no. 27 and ward no. 44 (56.67% each) and ward no. 04, ward no. 07, ward no. 18, ward no. 24 and ward no. 39 (53.33% each). Least of tap water supply was recorded in ward no. 22 (23.33%) followed by ward no. 34 (26.67%) and ward no. 17 and ward no. 21 (30% each). Hand pump source of drinking water was recorded only in ward no. 18 (10%) followed by ward no. 04, ward no. 22 and ward no. 25 (6.67% each).

In the present study the tube wells as a drinking water source have placed. There was no fifth around the source. They have recorded maximum in ward no. 15 (46.67%) followed by ward no. 16 (36.67%) and ward no. 21, ward no. 24 and ward no. 36 (33.33% each). They have been reported minimum in ward no. 42 (6.67%) followed by ward no. 4, ward no. 18, ward no. 27, ward no. 28, ward no. 32, ward no. 37, ward no. 38 and ward no. 41 (13.33% each).

In the study areas the tube wells as a drinking water source which have placed. There was fifth present around source. They have been recorded maximum in ward no. 17 (26.67%) followed by ward no.38 and ward no. 42 (23.33% each) and ward no. 22, ward no. 31 and ward no. 34 (20% each). They were reported minimum in ward no. 18, ward no. 36 and ward no. 41 (3.33%) followed by ward no. 4, ward no. 14, ward no. 21, ward no. 23, ward no. 27, ward no. 29 and ward no. 37 (6.67% each).

In the present study the tube wells as a drinking water source which was placed near drain. They have been recorded maximum in ward no. 35 (16.67%) followed by ward no. 41 and ward no. 38 (13.33% each) and ward no. 34, ward no. 29 and ward
no. 22 (10% each). They have been reported lowest in ward no. 04, ward no. 17, ward no. 19, ward no. 23, ward no. 25, ward no. 31 and ward no. 42 (3.33% each).

In the study areas the tube wells as a drinking water source which were located on the clean place. They have been recorded maximum in ward no. 37 (40%) followed by ward no. 41 (36.67% each) and ward no. 29 (33.33%). They have been reported minimum in ward no. 31, ward no. 35 and ward no. 44 (6.67%) followed by ward no. 13, ward no. 16, ward no. 19, ward no. 28 and ward no. 30 (10% each).

In the present study the tube wells as a drinking water source which has placed near septic tank. They have been recorded only in ward no. 38 (10%) followed by ward no. 20, ward no. 25, ward no. 28, ward no. 34 and ward no. 35 (3.33% each).

In the present study the tap water line supply on the dry areas. They have recorded maximum in ward no. 24 (46.67%) followed by ward no. 26 and ward no. 39 (40% each) and ward no. 16 (36.67% each). They have been reported minimum in ward no. 38 (6.67%) followed by ward no. 22 (10%) and ward no. 17, ward no. 29, ward no. 34 and ward no. 41 (13.33% each).

In the study areas the tap water line has crossed the sewage line. They have been recorded maximum in ward no. 32 and ward no. 42 (10% each). They have been reported minimum in ward no. 13, ward no. 17, ward no. 21, ward no. 29, ward no. 34, ward no. 36 and ward no. 44 (3.33%) followed by ward no. 07, ward no. 14, ward no. 18, ward no. 20, ward no. 27, ward no. 30, ward no. 35, ward no. 38 and ward no. 41 (6.67% each).

In the present study the tap water line which has submerged in sewage. They have recorded maximum in ward no. 35 and ward no. 44 (13.33% each). They have been reported lowest in ward no. 13, ward no. 19, ward no. 29, ward no. 31, ward no. 34 and ward no. 37 (3.33% each).
In the study areas tap water line which has passed through fifth. They have been recorded maximum in ward no. 32 (26.67%) followed by ward no. 28, ward no. 31, ward no. 37, ward no. 38 and ward no. 44 (20% each). They have been reported least in ward no. 16 and ward no. 26 (3.33% each) followed by ward no. 20, ward no. 22, ward no. 24 and ward no. 3 (6.67% each).

In the present study the Hand pump as water source which has located. There was no fifth around source. They have recorded maximum in ward no. 22 and ward no. 25 (6.67% each). They have been reported minimum in ward no. 04 and ward no. 18 (3.33% each).

In the study areas the hand pumps as water source which has placed. There was fifth present around source. They have been recorded maximum in ward no. 18 (6.67%). They have been reported minimum in ward no. 04 (3.33%). None of the hand pump as drinking water source was near the drain and the septic tank in all wards of North Indore city.

Condition of drinking water source (Hand pump) their neighbourhoods

Hand pump water supply was also a limited facility of water to population of ward no. 04, ward no. 18, ward no. 22 and ward no. 25.

In the present study three hand pumps as drinking water source were reported in the ward no. 18 in which one has completed plate form and two hand pumps were casing leak proof damage.

Two hand pumps were reported in the ward no. 4 in which one was completed plate form and other was casing leak proof damage.

Two hand pumps as drinking water source were completed plate form with parapet lining reported in the ward no. 22 and ward no. 25 each.

Common and Water borne diseases in the areas:
Many people in the world suffer from water borne diseases. Water receives microorganisms from air, sewage, soil and other organic wastes. Faecal pollution of water leads to introduction of variety of intestinal pathogens that causes water borne diseases (Jacobson and Lan, 1988).

To avoid the spread of water borne diseases in the community and to ensure the safety of drinking water, the open defecation should be stopped and the regular water quality monitoring should be performed (Sobsey and Pfaender, 2002).

Millions of people in many states in India are affected by waterborne diseases and a large number of them are in crippling stage and leading vegetative life (Tambekar et al., 2008).

Where availability of safe water and standard of sanitation is not very good, the risk of acquiring water borne infection can be as high as 90% like water borne hepatitis A, E, cholera, diarrhoea, dysenteries, typhoid and parasitic diseases, etc (Saeed and Behzad, 2006).

In the present study epidemiological survey of the urban population was found infected with various water born and other related diseases. Various diseases like typhoid, dysentery, diarrhoea, cholera, amoebiasis, giadiasis, hepatitis, fluorosis, poliomyelitis, malaria, skin diseases, and joint / waist pain were reported in the study area.

In the present study maximum cases of cold cough (19.18%) and skin diseases (15.16%) were reported followed by pain in joint (14.79%), amoebiasis (13.32%), diarrhoea (9.41%), indigestion (6.99%), dysenteric (6.72%), malaria (4.89%), jaundice (3.70%), typhoid (2.62%) and T.B. (1.07%) and Least incidence of the cholera (0.15%) and fluorosis (0.39%). The case of poliomyelitis was not reported in the study area.
Singh and Devi (2006) reported that the water-borne diseases such as diarrhoea (34.84%), worm infestation (27.27%), typhoid fever (21.21%) and jaundice (16.66%) in studying of water borne morbidities of Thanga village, Manipur. Karn and Harada (2002) reported that the maximum case of diarrhoea (94) followed by malaria (59), typhoid (36) and cholera (3) while studying on health survey of Mumbai city, India.

Among the wards maximum per cent of the cold cough as a disease was found in ward no. 27 (27.53%) followed by ward no. 19 (27.19%) and ward no. 25 (26.68%). Lowest cases of the cold cough as a disease was reported in ward no. 39 (10.12%) and ward no. 38 (11.98%).

The skin diseases were maximum in ward no. 38 (25.75%) followed by ward no. 23 (22.22%) and ward no. 24 (21.71%). Least of the skin diseases were recorded in ward no. 44 (6.83%) followed by ward no. 41 (9.45%) and ward no. 29 (9.88%). Maximum case of pain in joint as a disease was recorded in ward no. 22 (29.00%) followed by ward no. 21 (25.71%), ward no. 26 (22.97%), ward no. 30 (22.92%) and ward no. 29 (22.81%). Minimum case of pain in joint was recorded in ward no. 44 (4.39%) followed by ward no. 36 (5.44%) and ward no. 18 (7.98%).

In the present study maximum incidence of amoebiasis were recorded in ward no. 13 (18.77%) followed by ward no. 17 (18.43%) and ward no. 16 (18.32%). Least case of amoebiasis were reported in ward no. 38 (5.98%) followed by ward no. 25 (8.25%) and ward no. 20 (8.27%).

The incidence of diarrhoea disease was recorded maximum in ward no. 34 (16.34%) followed by ward no. 39 (15.48%), ward no. 42 (13.85%), ward no. 36 (13.36), ward no. 44 (13.22%) and ward no. 25 (13.11%). Least case of diarrhoea diseases were recorded in ward no. 21 (3.67%) followed by ward no. 23 (4.76%) and ward no. 20 (5.11%). Maximum case of indigestion as a disease was recorded in ward no. 39 (14.28%) followed by ward no. 18 (13.14%), ward no. 38 (12.57%) and ward...
no. 41 (12.16%). Minimum case of indigestion was recorded in ward no. 29 (2.28%), ward no. 21 (2.44) and ward no. 36 (2.97%) followed by ward no. 34 (3.46%), ward no. 20 (3.54%) and ward no. 23 (3.97%).

In the present study maximum incidence of dysenteric were recorded in ward no. 30 (16.58%) followed by ward no. 44 (15.34%) and ward no. 39 (13.09%). Lowest case of dysenteric was reported in ward no. 16 (1.57%) and ward no. 7 (1.65%) followed by ward no. 17 (2.35%), ward no. 23 (2.38) and ward no. 20 (2.75%). Maximum case of malaria as a disease was recorded in ward no. 39 (8.93%) followed by ward no. 17 (7.45%), ward no. 25 (7.28%) and ward no. 19 (7.02%). Minimum case of malaria was recorded in ward no. 24 (2.13%), ward no. 26 (2.25%) and ward no. 23 (2.78%) followed by ward no. 32 (2.98%), ward no. 28 (3.12%) and ward no. 21 (3.26%).

In the study areas maximum incidence of jaundice were recorded in ward no. 20 (9.06%) followed by ward no. 32 (6.67%). Least case of jaundice were reported in ward no. 13 (1.14%) followed by ward no. 30 (1.46%) and ward no. 27 (1.62%).

The incidence of typhoid disease was maximum in ward no. 28 (4.91%) followed by ward no. 44 (4.76%), ward no. 20 (4.72%), ward no. 33 (4.38%), ward no. 23 (4.36%) and ward no. 14 (4.06%) Least case of typhoid was recorded in ward no. 15 (0.52%) followed by ward no. 19 (0.88%), ward no. 30 (0.97%) and ward no. 36 (0.99%).

In the present study maximum incidence of T.B. were recorded in ward no. 14 (2.91%) followed by ward no. 21 (2.86%) and ward no. 7 (2.48%). Lowest case of T.B. was reported in ward no. 24 (0.35%) followed by ward no. 33 (0.44), ward no. 28 (0.45%) ward no. 18 (0.47%) and ward no. 39 (0.59%).

In the study areas incidence of cholera were reported in ward no. 16, ward no. 17, ward no. 18, ward no. 19, ward no. 21, ward no. 22, ward no. 29, ward no. 34 and ward no. 41 in which not more than one per cent.
The incidence of fluorosis was not more than 2% reported in the ward no. 16, ward no. 17, ward no. 18, ward no. 19, ward no. 20, ward no. 21, ward no. 22, ward no. 27, ward no. 28, ward no. 29, ward no. 30, ward no. 31, ward no. 32, ward no. 33, ward no. 34, ward no. 35, ward no. 36, ward no. 37, ward no. 38, ward no. 39, ward no. 41 and ward no. 42.

Thus in the present study was found that lower income group was more prone to various water born and related and diseases. Unhygienic habits, in illiteracy, lack of proper drainage system, unprotected sources of drinking water and lake of toilet facility were mainly responsible for spread of water- borne and water hygiene diseases.
Medical facility available in the areas

In the study area maximum available medical facility of Private (45.62%) followed by Ayurvedic (30.73%), Homeopathy (20.52%), Government (2.60%) and
Unani (0.52%). The Private medical facility maximum in wards were ward no. 26, ward no. 27, ward no. 32 and ward no. 36 (63.33% each) followed by ward no. 16 (60%), ward no. 17 (56.67%) and ward no. 39, ward no. 30 and ward no. 22 (53.33% each). Least of Private medical facility was available in ward no. 17 (30%) followed by ward no. 04, ward no. 23 and ward no. 31 (33.33% each). The Ayurvedic medical facility was maximum in ward no. 18 (50%) followed by ward no. 23 (46.67%) and ward no. 33 (43.33%). Least of Ayurvedic medical facility were recorded in ward no. 13, ward no. 15, ward no. 27, ward no. 30, ward no. 36 and ward no. 44 (20% each). Maximum medical facility of Homeopathy was recorded in ward no. 11 (36.67%) followed by ward no. 13 and ward no. 38 (33.33% each). Minimum available of homeopathy recorded in wards were ward no. 18 and ward no. 26 (6.67% each) followed by ward no. 16, ward no. 35 and ward no. 37 (10% each).

In the present study maximum Medical facility of Government recorded in ward no. 04 (13.33%) followed by ward no. 35 (10%). Least Medical facility of Government reported in ward no. 07, ward no. 14, ward no. 20 and ward no. 34 (3.33% each) followed by ward no. 13, ward no. 15, ward no. 16, ward no. 17, ward no. 32, ward no. 41 and ward no. 44 (6.67% each).

In the study areas the maximum 0.52 per cent of Unani medical facility was recorded only in ward no. 17 (10%). Least of Unani medical facility was recorded only in ward no. 19 (6.67%). In all other wards was none of medical facility of Unani.

Private as medical facility was prevalent in the study areas for the treatment of diseases. Although other system of treatment were also practiced by the urban population in the study area which included. Ayurvedic, Homeopathic, Government and Unani.

Unani system of medicine was not common in the study areas as only 0.52 per cent of the diseased population adapted it.

**Study of public latrine facility:**
In the study area open field defecation was no common practice as more than 13.44% of population showed this old trend of defecation. In ward no. 18 and ward no. 34 (30% each) and ward no. 22 (40%) no facility was there so ultimately open field defecation was the only place where people where eased out. Other wards more than 15% of the surveyed population showed this trend were ward no. 07, ward no. 23, ward no. 25, ward no. 31 and ward no. 33 (16.67% each), ward no. 04, ward no. 20 and ward no. 44 (20% each), ward no. 21, ward no. 41 and ward no. 17 (23.33% each) and ward no. 19 and ward no. 42 (26.67% each). Total 85% of the surveyed population was provided with either community or home toilet facility. Community toilet were maximum in ward no. 15 and ward no. 20 (13.33% each) followed by ward no. 13 and ward no. 30 (6.67% each). Minimum community toilet facility in wards were ward no. 18, wards no. 19, ward no. 21, and ward no. 27 (3.33% each). In other wards were not found to have any community toilet facility. Personal toilet were maximum in ward no. 37 and ward no. 38 (100% each) followed by ward no. 27 and ward no. 29 more than 90% of the served population possessed personal toilet. In other wards more than 60 percent of the served population was provided with this facility. Sewer line for disposal of wastes and excrement was available in most of wards of North Indore city. In the other wards toilet were either traditional or attached to septic tank. Traditional type of toilet have maximum in ward no. 21. Most of toilets attached to septic tank were found in ward no. 36 followed by ward no. 29, ward no. 30 and ward no. 27 more than 80% of surveyed population possessed this facility.

**Study of Population density**

In the study area maximum population density were reported in ward no. 24 (3.45%) followed by ward no. 29 (3.42%) and ward no. 32 (3.41%). The population density has been recorded minimum in ward no. 37(2.75%) followed by ward no. 04 (2.86%), ward no. 27 (2.87%) and ward no. 38 (2.89%). The maximum density of male has been reported in ward no. 34 (59.65%) followed by ward no. 21 (59.21%),
ward no. 17 (57.28%) and ward no. 18 (55.46%). Minimum density of male was reported in ward no. 28 (47.93%) followed by ward no. 36 (48.29%), ward no. 25 (49.76%) and ward no. 23 (50.70%). The density of female has been reported maximum in ward no. 28 (52.07%) followed by ward no. 36 (51.70%), ward no. 23 (50.24%) and ward no. 23 (49.24%). Least density of female was reported in ward no. 34 (40.35%) followed by ward no. 21 (40.49%), ward no. 18 (42.07%) and ward no. 17 (42.72%).