A time-series analysis of air pollution and mortality in Ludhiana city, India

INVESTIGATORS

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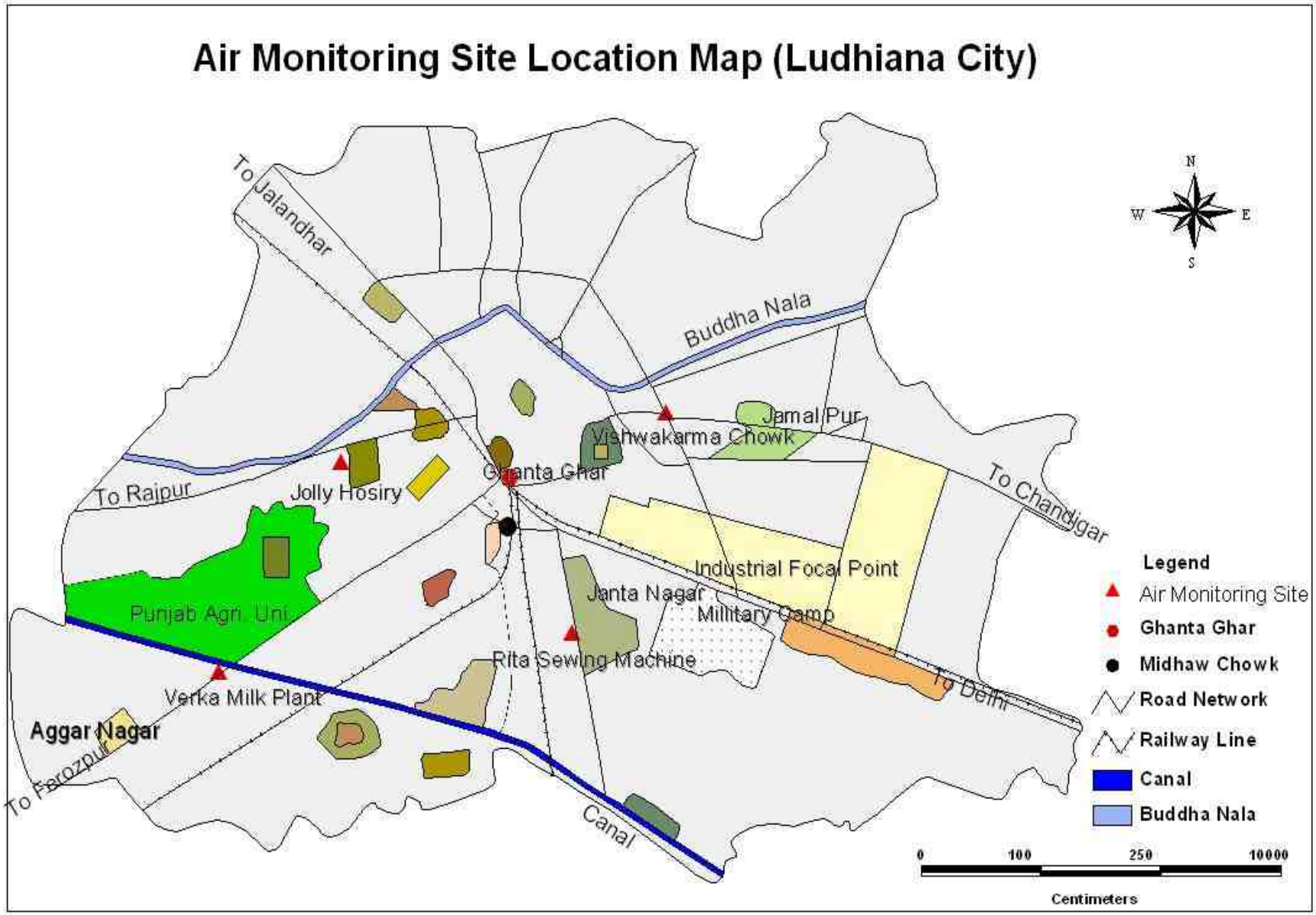

Air Monitoring Site Location Map (Ludhiana City)
To Jalandhar
Buddha Nala
Jamal Pur
Vishwakarma Chowk
Ghanta Ghar
To Raipur
Jolly Hosiry
To Chandigar
Industrial Focal Point
Janta Nagar
Military Camp
Punjab Agri. Uni.
Rita Sewing Machine
To Delhi
Verka Milk Plant
Aggar Nagar
To Ferozpur
Canal
N
W
E
S
Legend
Air Monitoring Site
Ghanta Ghar
Midhaw Chowk
Road Network
Railway Line
Canal
Buddha Nala
0
100
250
10000
Centimeters

Air Quality Data (2002-04)

- Three pollutants RSPM, NOx and SO_2 were measured
- Air quality monitoring is done at four sites
- Monitoring is carried out at two sites on alternate day
  - Site 1 and 3 Mon, Wed. & Fri.
  - Site 2 and 4 Tue., Thur. & Sat.
  - No recording is done for Sunday and holidays
- Bureau of Indian Standards were used for the monitoring of air pollutants i.e. RSPM, NOx and SO_2
- Methods
  - Gravimetric method for RSPM
  - Chemical method for NOx and SO

Meteorological Data (2002-04)

- Meteorological Station: Punjab Agriculture University, Ludhiana
- Latitude: 30.54°N, Longitude: 75.48°E
- Height above mean sea level: 247 meters
- Monitoring is carried out for temperature, relative humidity, wind speed and wind direction
- Recording available for all the 365 days

Mortality Data

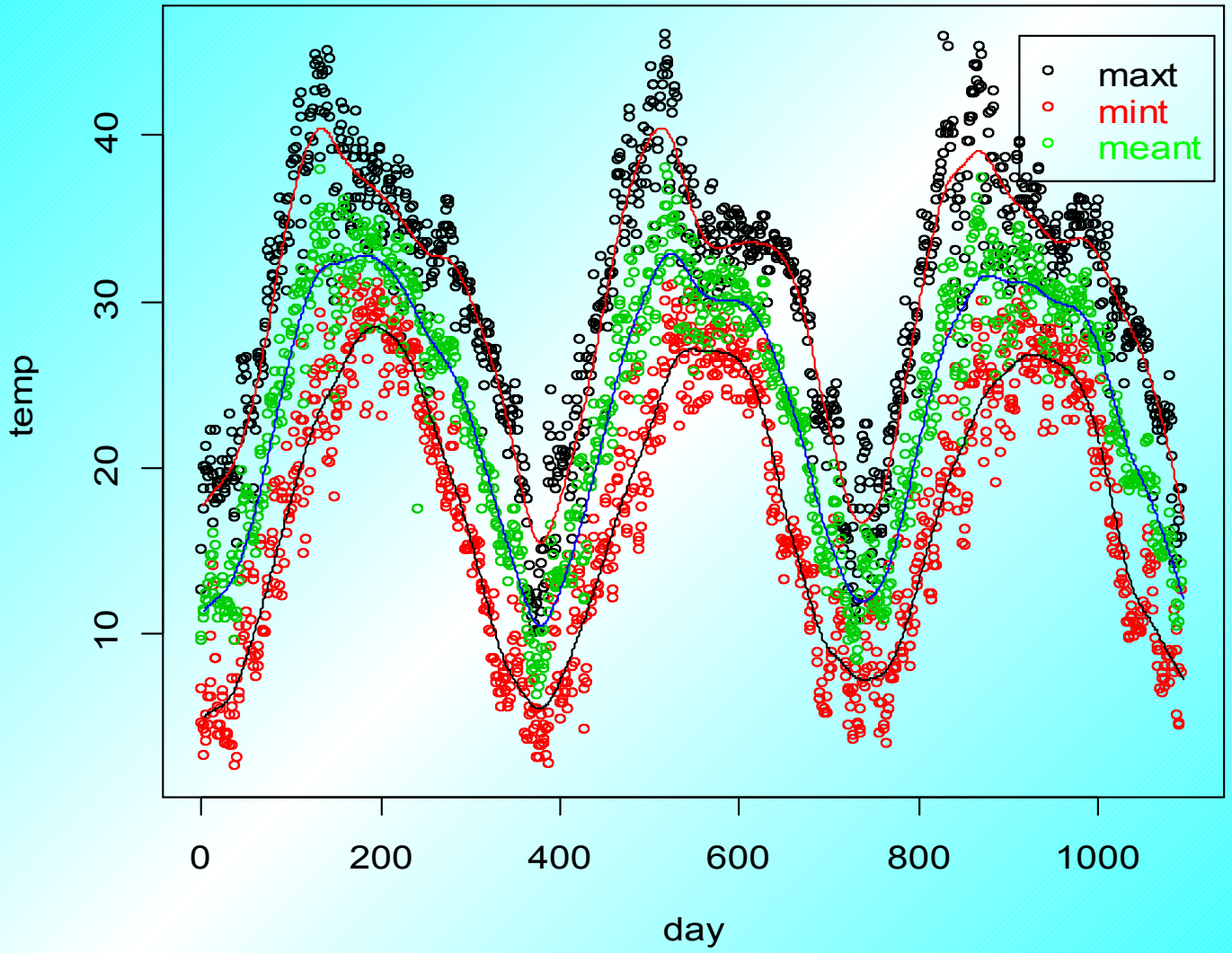
- Mortality data has been collected for year 2004
- Following information is extracted from death records:

Name	Date of death
Father's Name	Place of death
Age	Residence
Sex	Cause of death

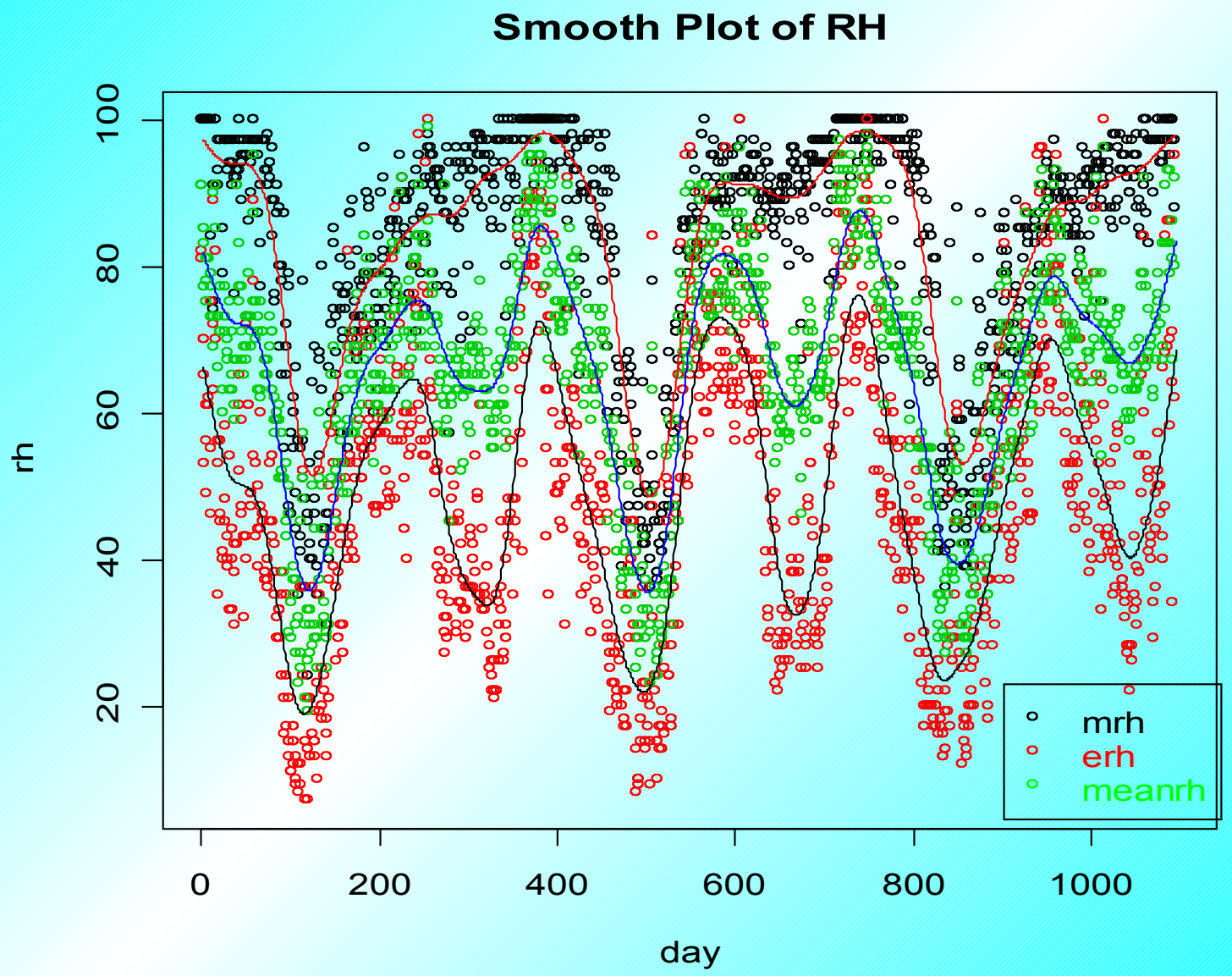
Mortality Data

- Ludhiana City is divided into four zones A, B, C and D for Birth and Death registration
- There are two centres of registration
    1. Ghantaghar for Zone A & B
    2. Midhaw Chowk for Zone C & D
- Both the centers are under municipal corporation office
- Manual recording is carried out at both centers
- Hospital based deaths are directly reported to the municipal corporation office

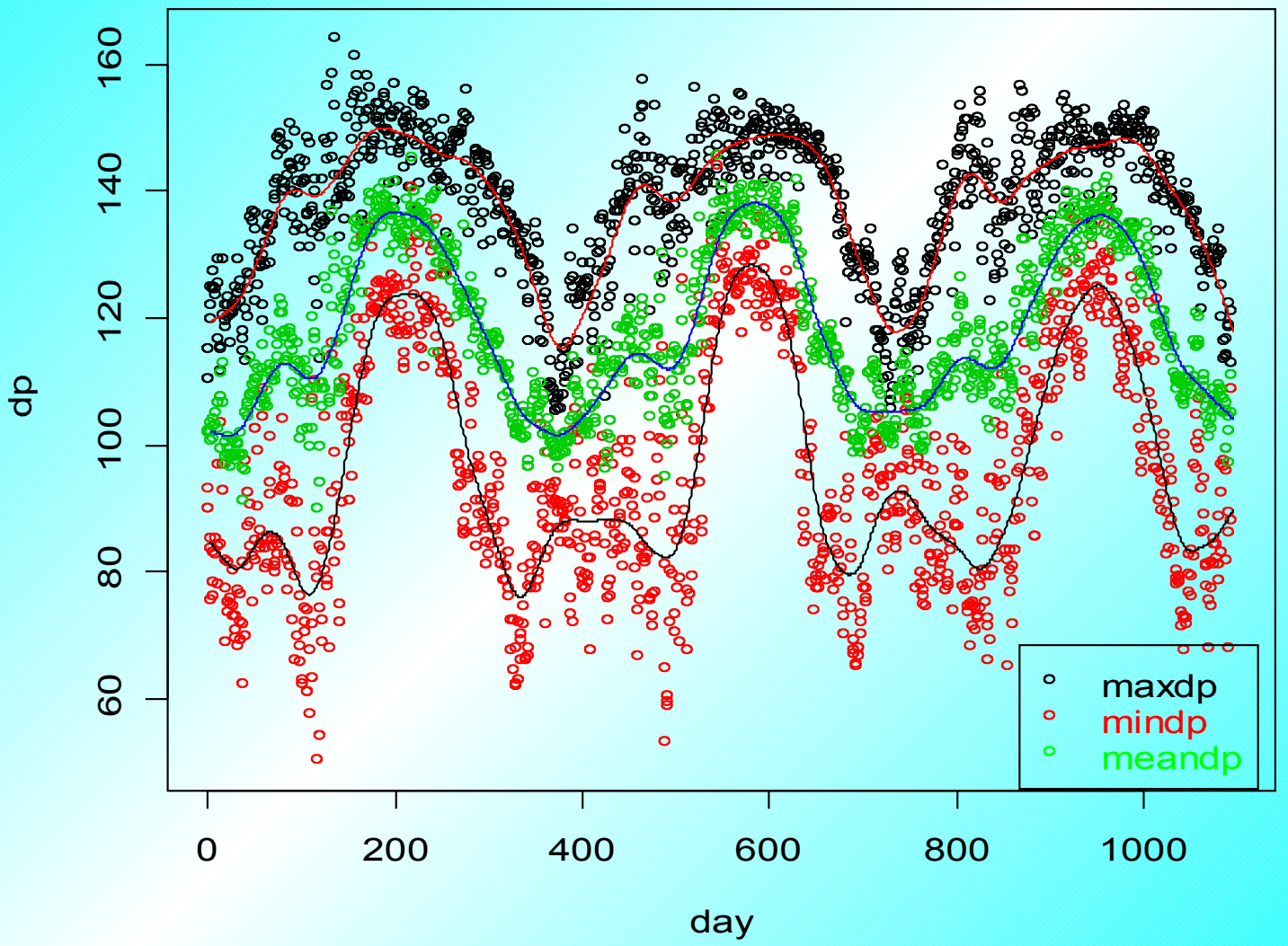
Daily variation of Temperature for the year 2002-04



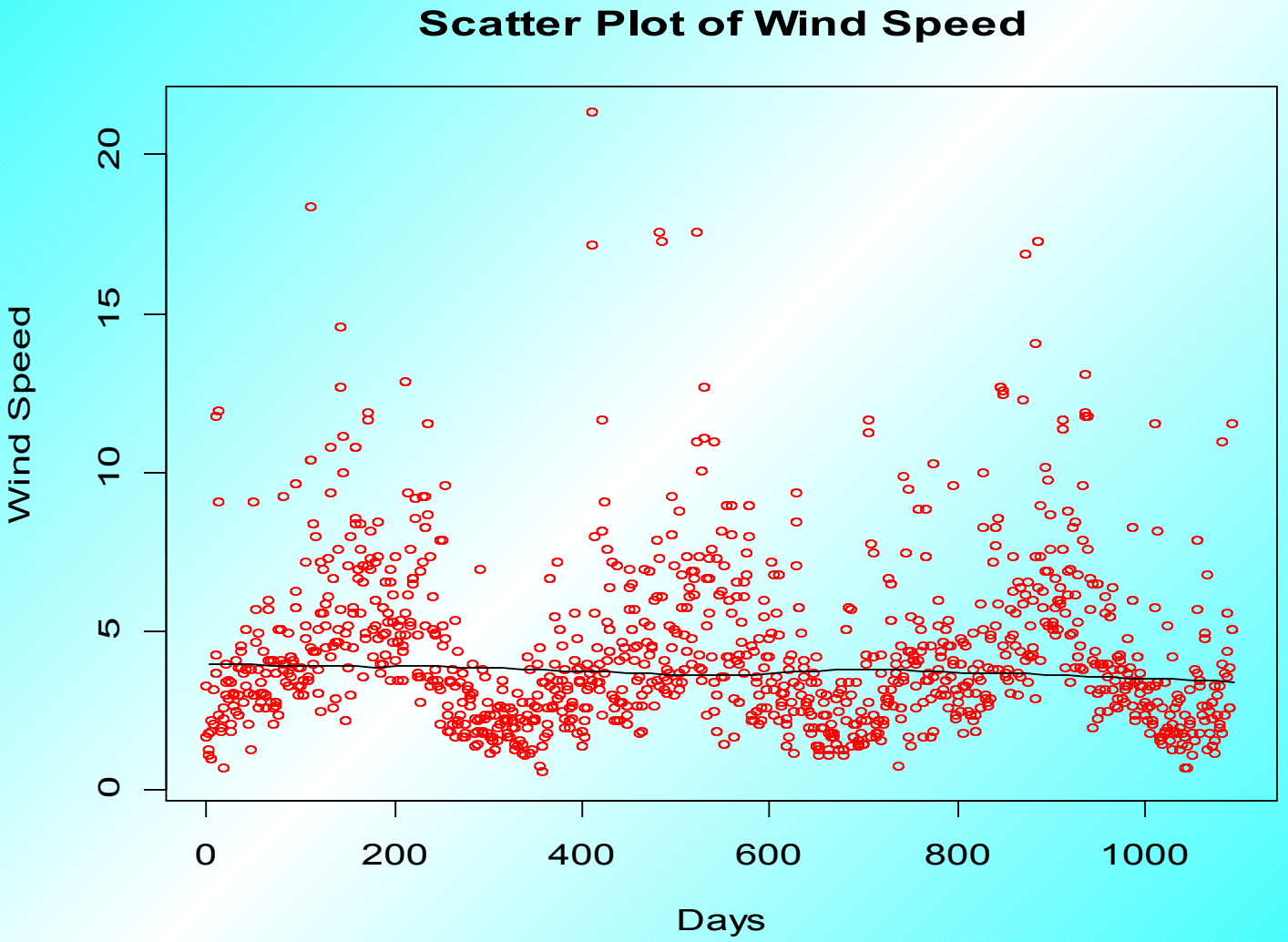
Daily variation of Relative Humidity for the year 2002-04



Daily variation of Dew Point for the year 2002-04



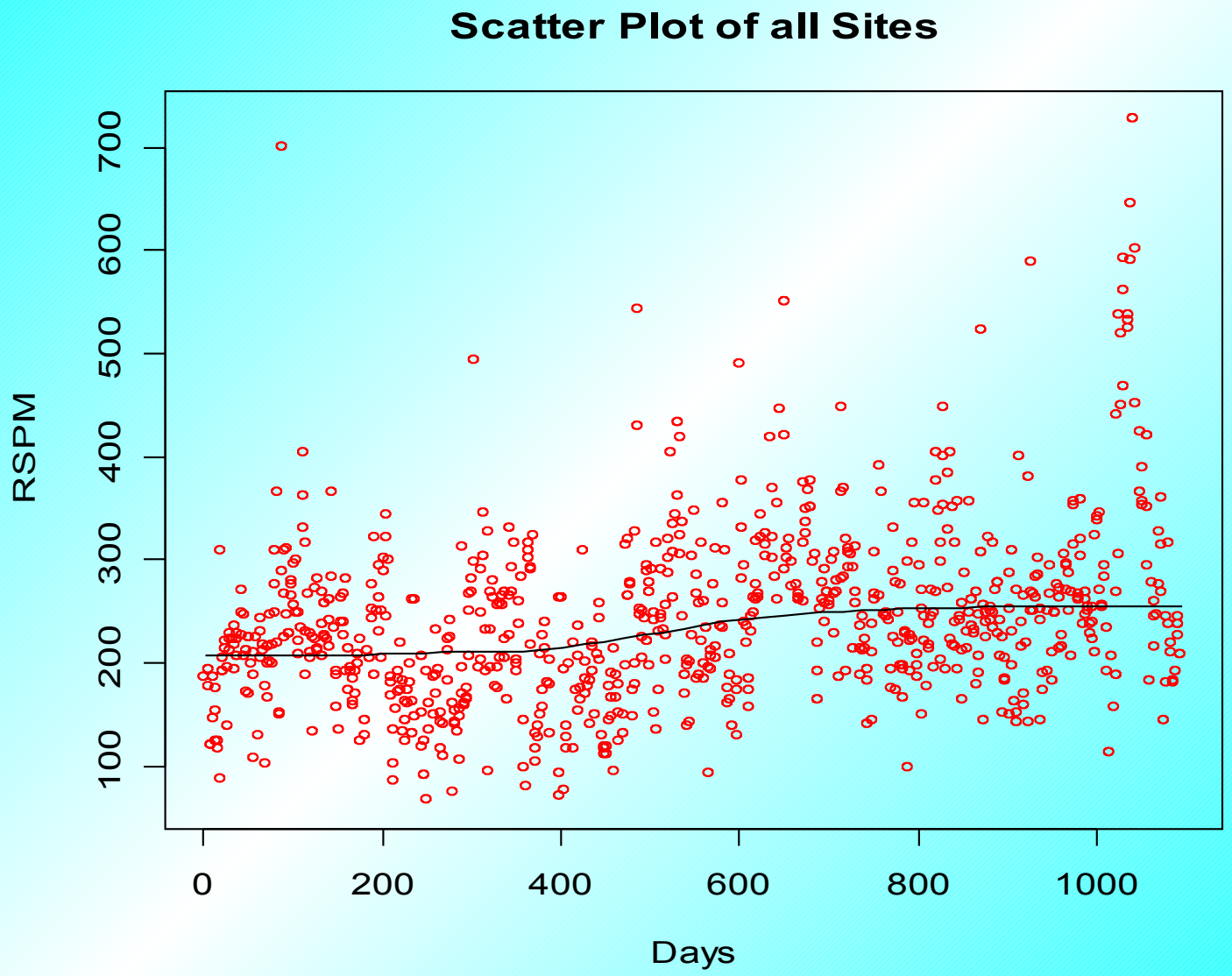
Daily variation of Wind Speed for the year 2002-04



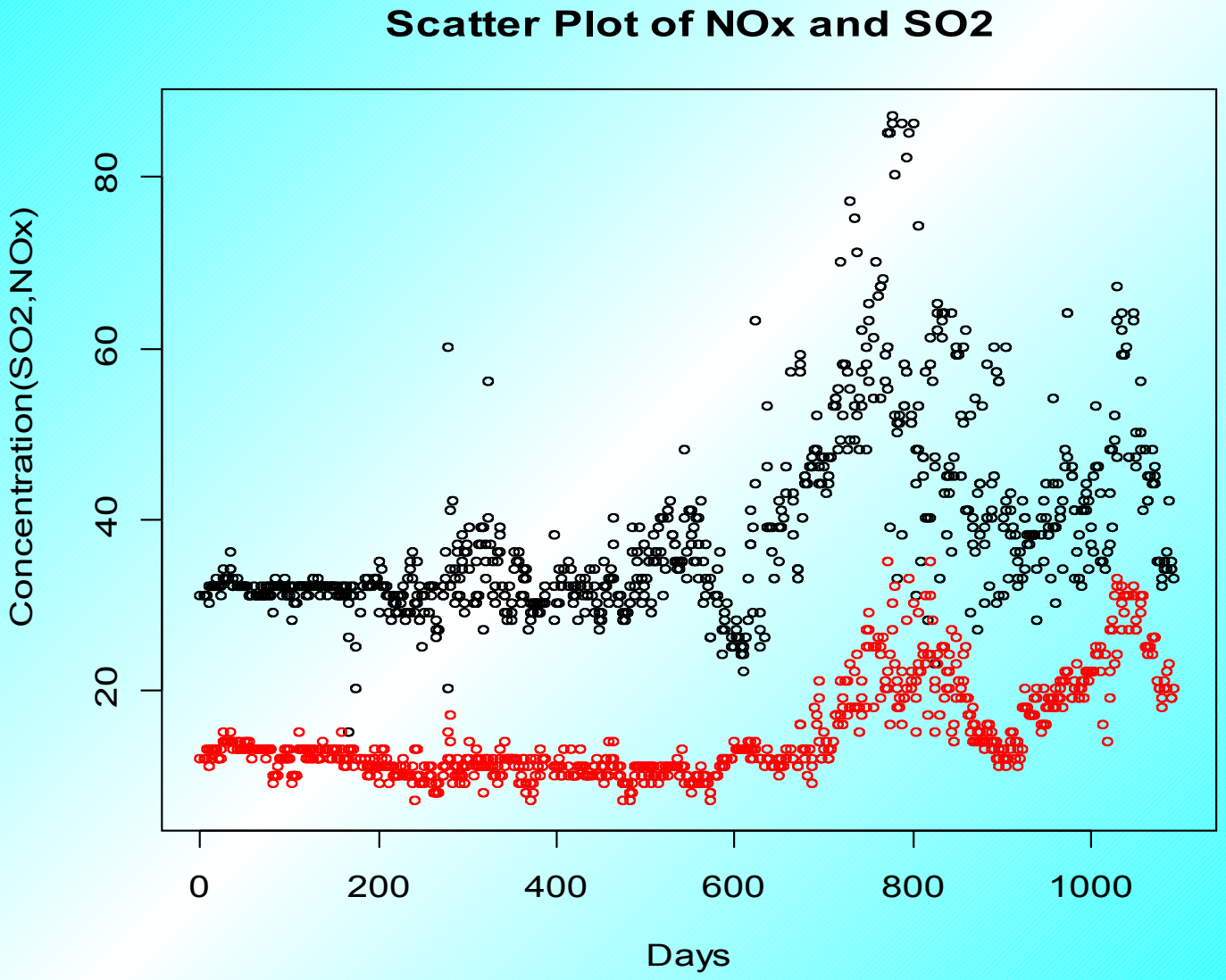
Site wise air pollution monitoring days for the year 2002-04

S. No.	2002	2003	2004
Site 1	130	103	151
Site 2	124	91	No Observation
Site 3	143	137	126
Site 4	140	122	134
Total	537	453	411

Daily variation of RSPM for the year 2002-04



Daily variation of NOx and SO2 for the year 2002-04

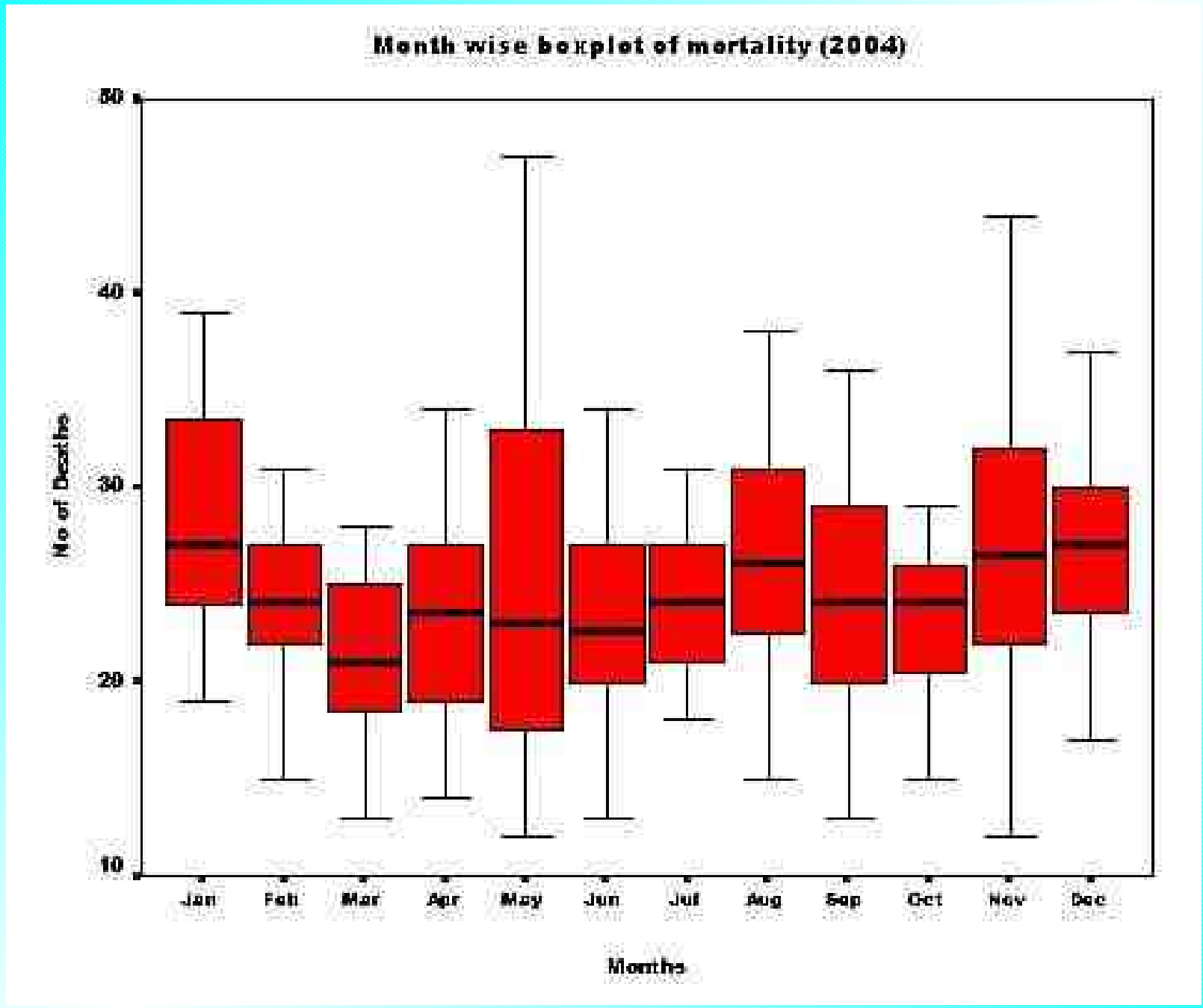


Preliminary Analysis for Mortality (2004)

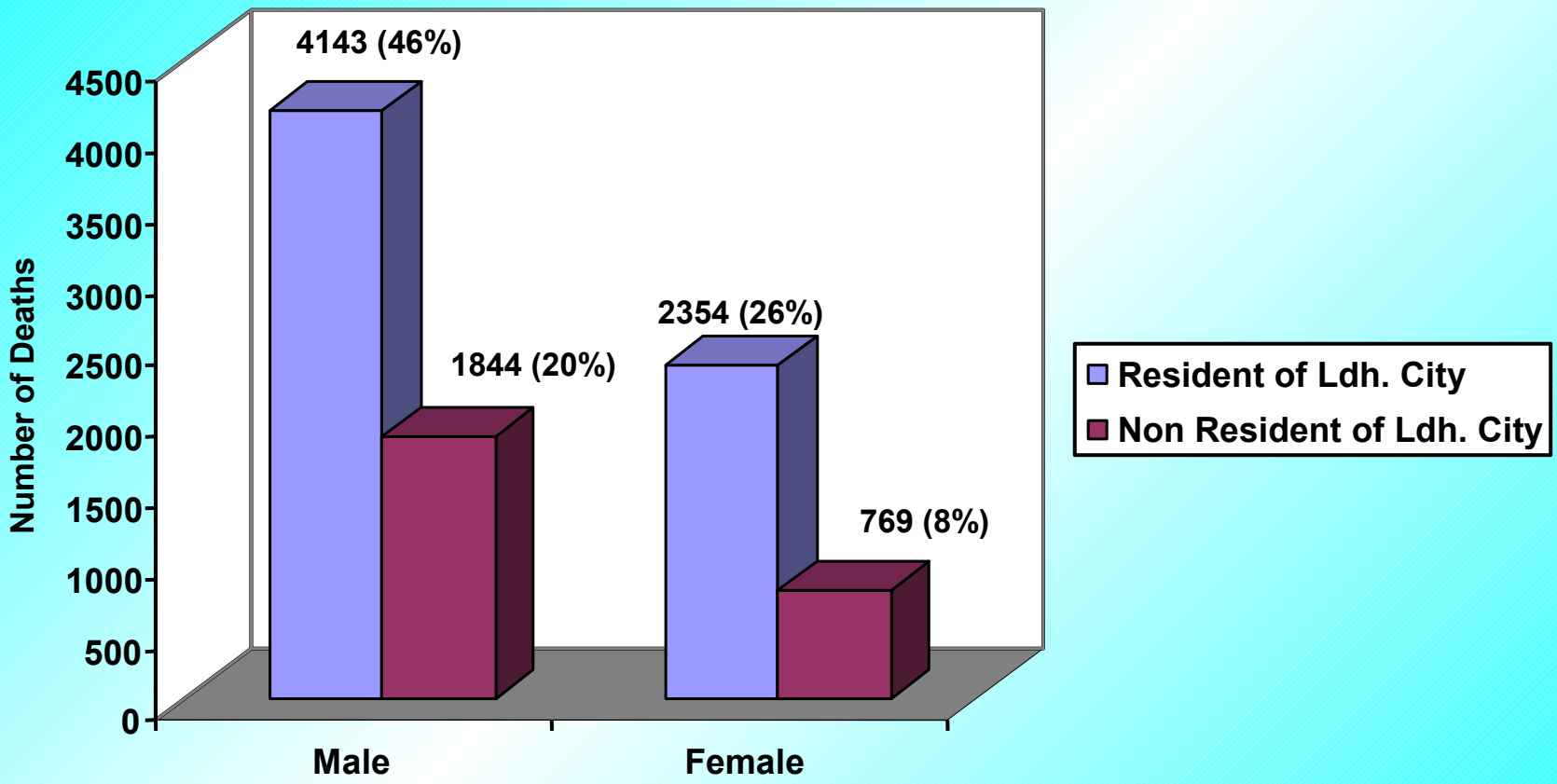
- Total deaths : 9110
- Average number of deaths per day : 25
- Number of male deaths : 5987
- Average number of male deaths per day : 16
- Number of female deaths : 3123
- Average number of female deaths per day : 9

Monthly Age-wise Distribution of Deaths, Year 2004

Month	0-4 yrs	5-44 yrs	45-64 yrs	≥ 65 yrs	Total
Jan	41	190	272	392	895
Feb	42	135	231	295	703
March	32	171	228	240	671
April	35	203	198	255	691
May	41	230	217	305	793
June	49	206	196	248	699
July	50	200	242	257	749
Aug	52	242	242	268	804
Sept	44	189	242	252	727
Oct	44	204	236	246	730
Nov	44	210	255	300	809
Dec	41	182	265	351	839
Total	515	2362	2824	3409	9110

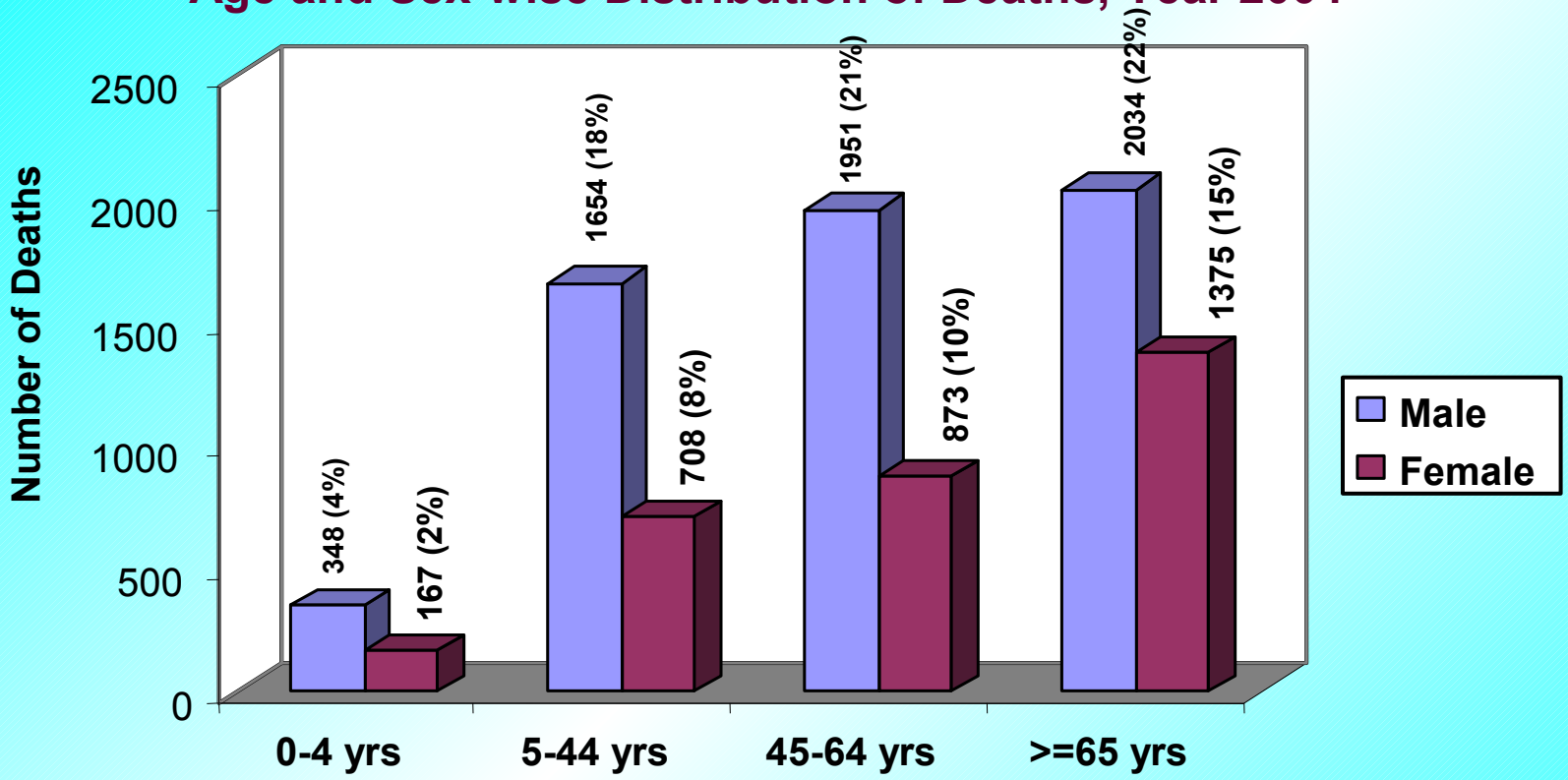

Month wise boxplot of mortality (2004)
No of Deaths
50
40
30
20
10
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months

Resident and sex wise Distribution of Deaths, Years 2004



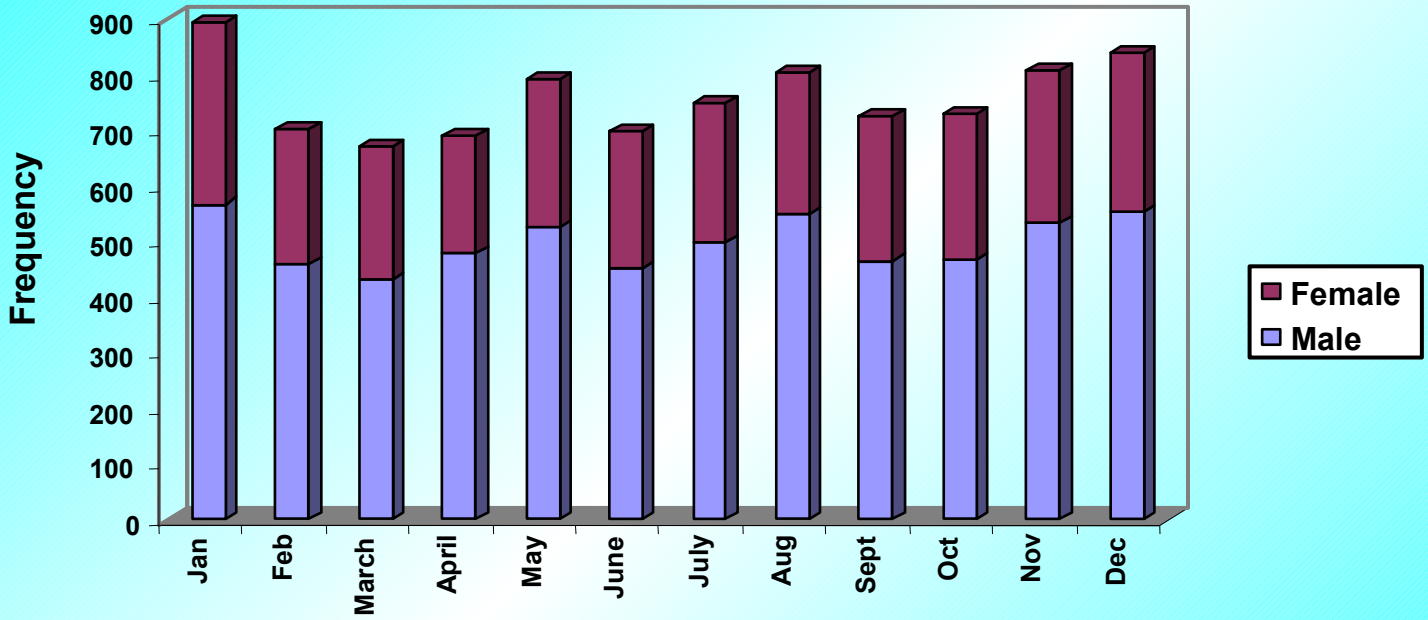
- 72% were residents of Ludhiana
- Male deaths (66%), female deaths (34%)

Age and Sex-wise Distribution of Deaths, Year 2004



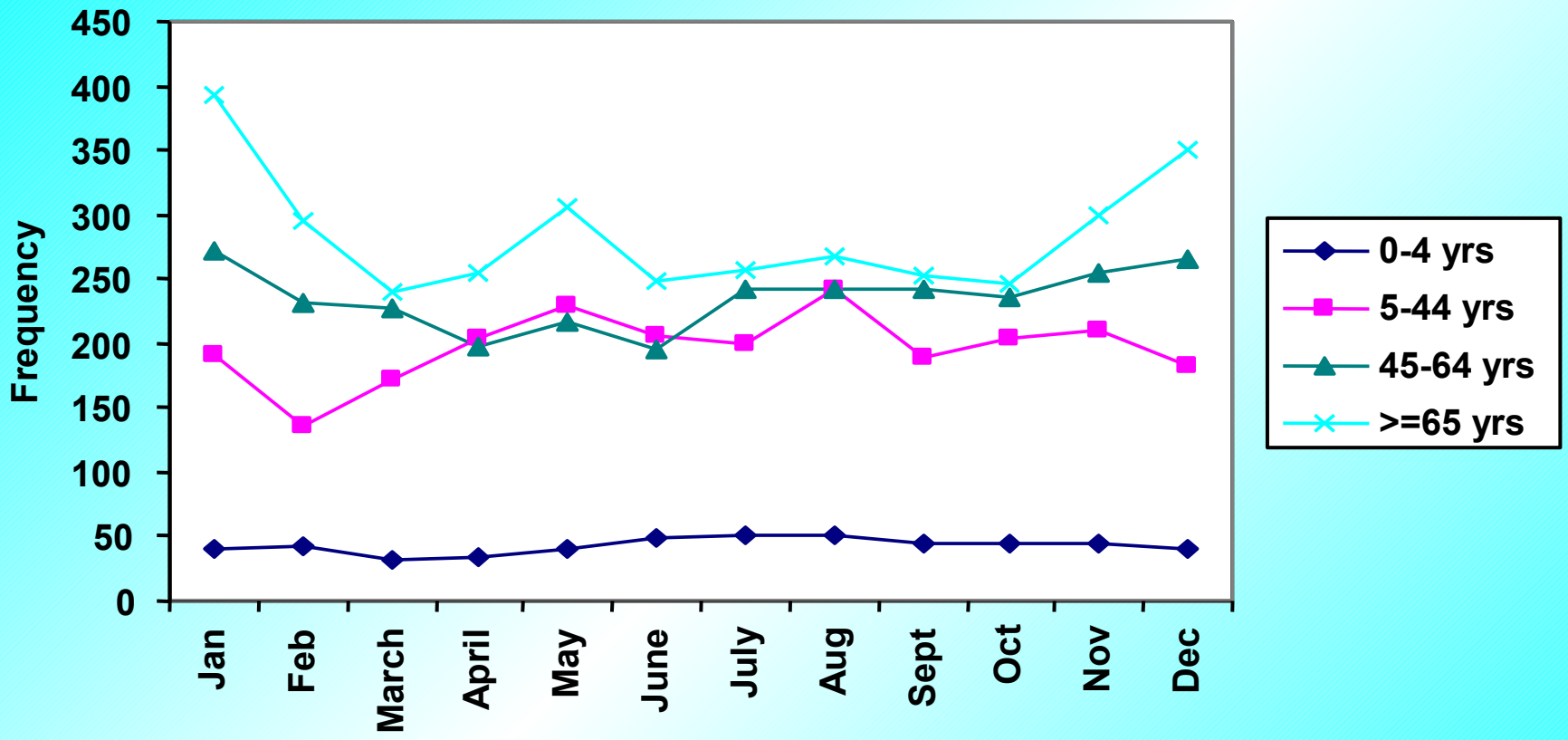
- In each age category there are more male deaths as compared to female deaths
- 67% deaths occurred in age groups ≥ 45 years
- Only 6% of deaths occurred in age group 0-4 years

Monthly Sex-wise Distribution of Deaths, Year 2004



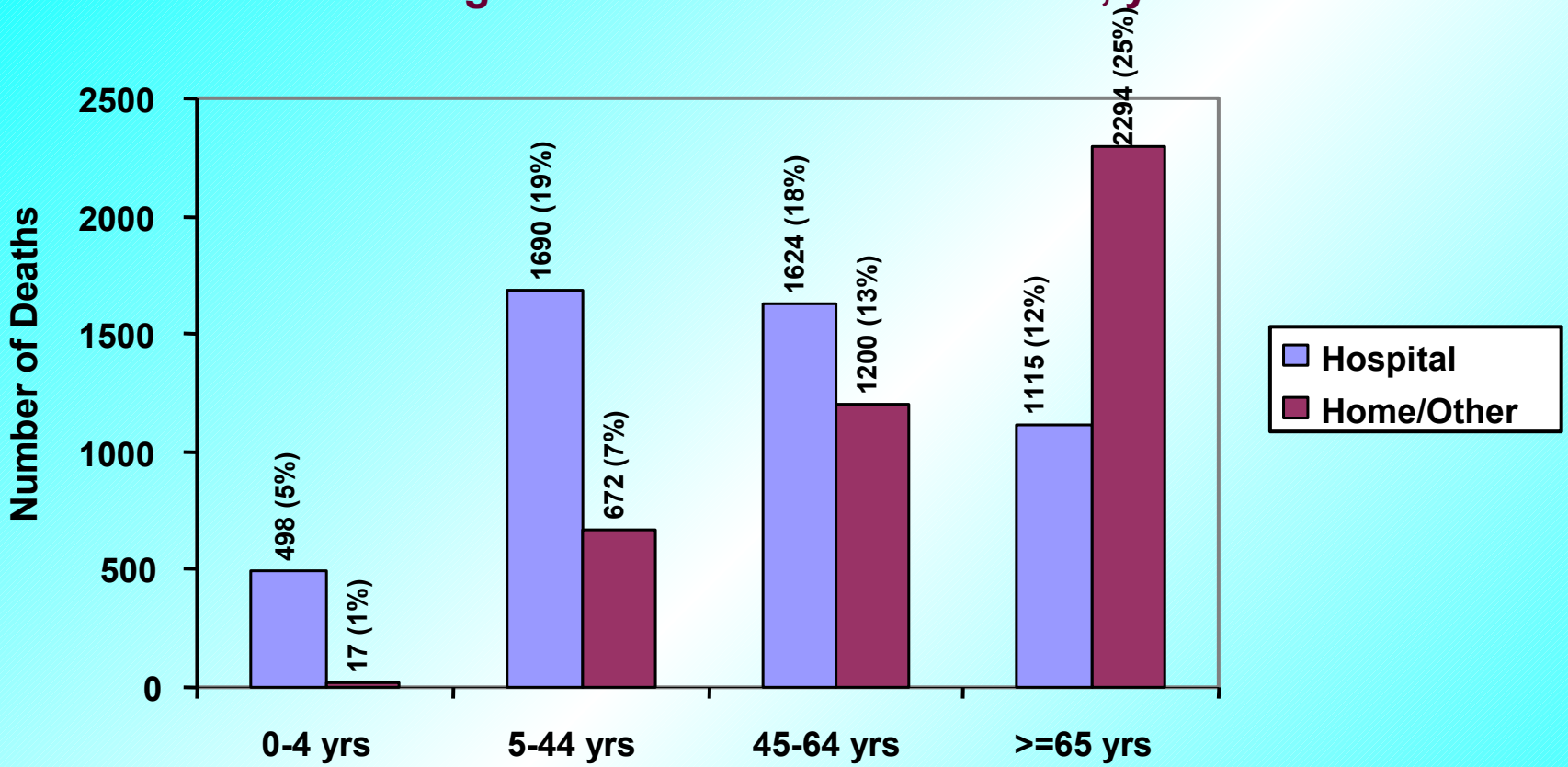
- Winter deaths (October to March) – 51%
- Summer deaths (April to September) – 49%
- More deaths occurred during peak winter season i.e. Nov, Dec, Jan

Monthly Age-wise Distribution of Deaths, Year 2004



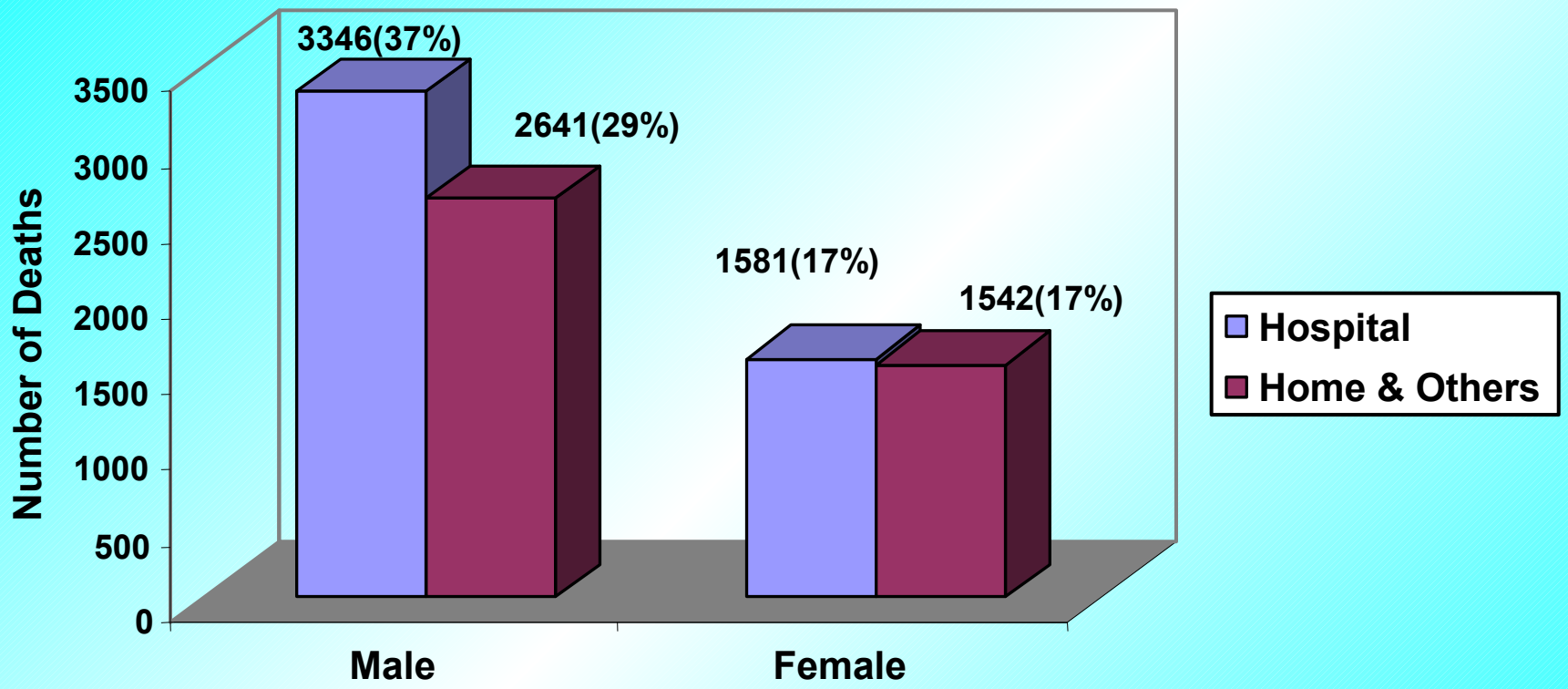
- Maximum number of deaths occurred in age category ≥ 65 years
- 5-44 years and 44-65 years have similar distribution of deaths for three summer months i.e. April, May and June
- Even distribution of deaths for age category 0-4 years

Location and Age-wise Distribution of Deaths, year 2004



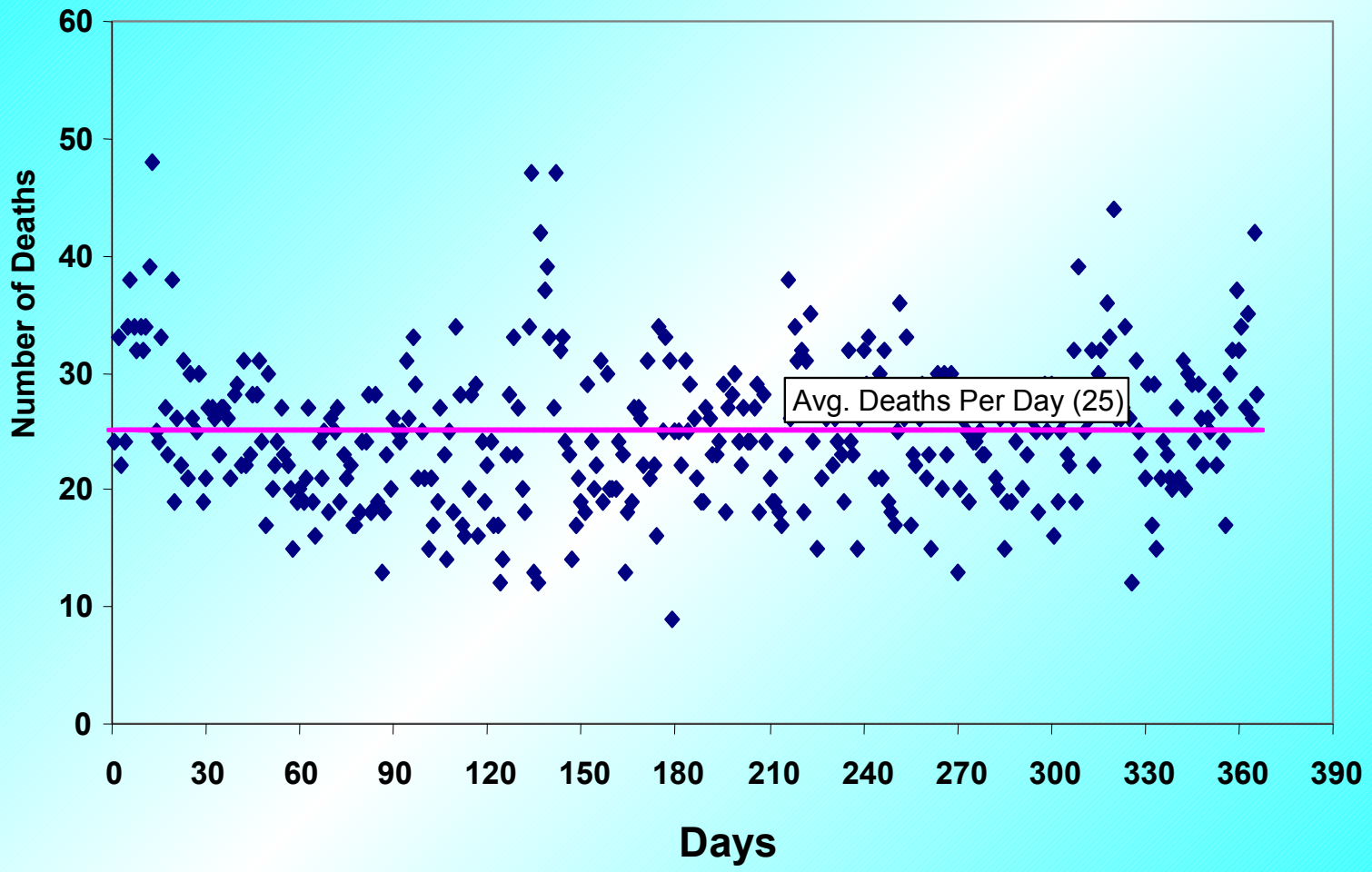
- There are more hospital deaths as compared home/others in each age category except for ≥ 65 years of age groups
- Maximum hospital deaths occurred in each age category 5-44 years (19%)
- Maximum home/others deaths occurred in age groups ≥ 65 years (25%)

Location and Sex wise Distribution of Deaths, Year 2004

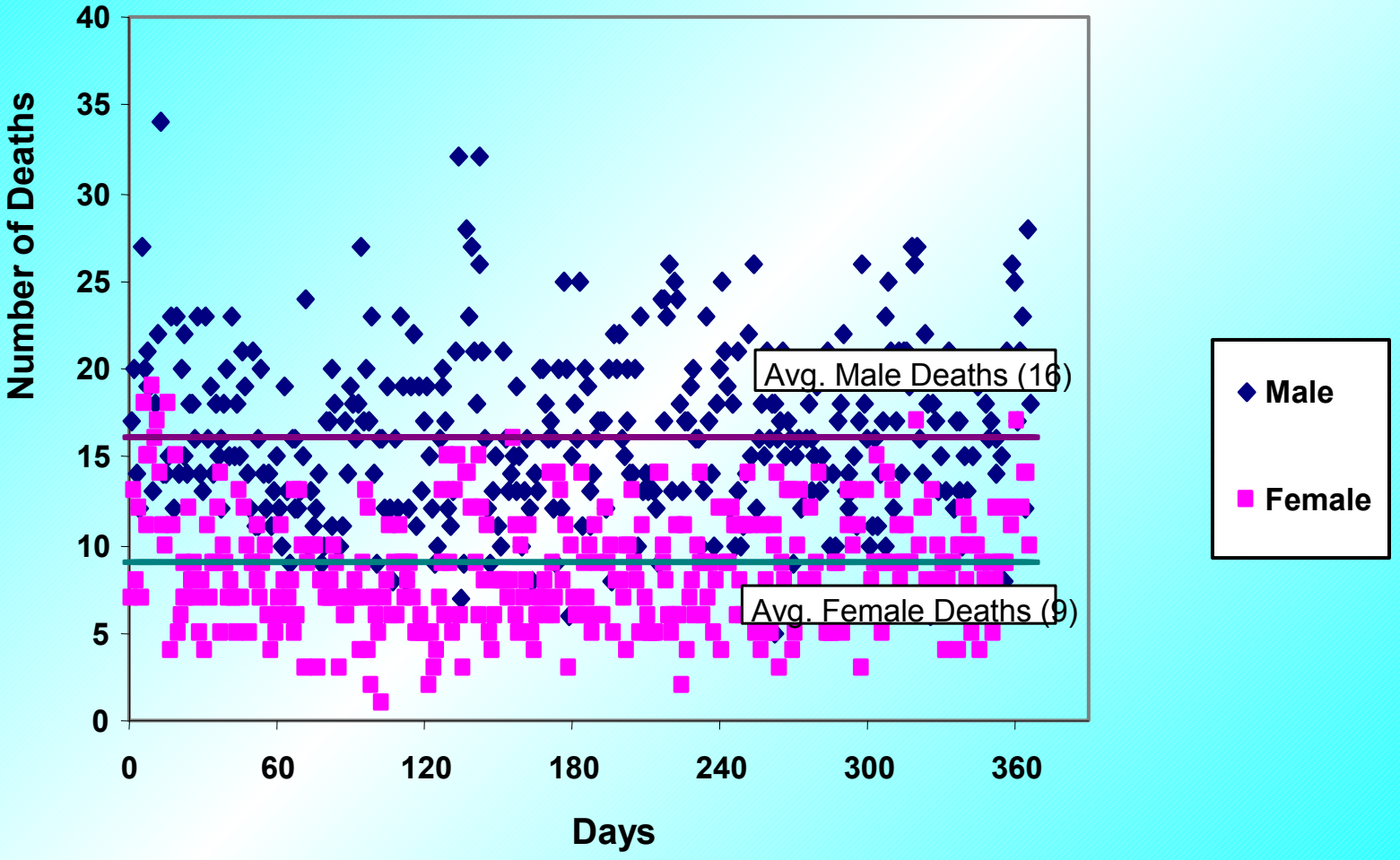


- 54% deaths occurred in hospitals and 46% in home/others
- In both categories there are more male deaths than females deaths

Daily Distribution of Deaths in Year 2004



Daily Sex-wise Distribution of Death 2004



General Issues

- **Site monitoring problems for air pollutants**
  Site 3 has only nine months data for year 2003
  Site 2 is lost due to non availability of sampler for year 2004

- **Missing Values**
  Single missing value between two adjacent values, then filling with the average of adjacent values.

- **Mortality data**
  Presently concentrating on all cause mortality

Future Plans

- Mortality data entry for the year 2002-2003 is in progress.
- Visibility data is being procured from meteorology department.
- Proposed model for missing values of air pollution is being developed
- Analysis of available data is in progress

Thanks