# A STUDY ON THE SPECTRUM OF VARIOUS INFECTIONS IN OVERWEIGHT, OBESE AND GROSSLY OBESE INDIVIDUALS WHO ARE NON DIABETIC AND HIV-NEGATIVE

***Dissertation submitted to***

*The Tamil Nadu Dr. M.G.R. medical University*

***for***

## M.D. DEGREE EXAMINATION

**BRANCH - I (GENERAL MEDICINE)**

**THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY**
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**MARCH 2008**

# CERTIFICATE

This is to certify that this dissertation entitled "**A STUDY ON THE SPECTRUM OF VARIOUS INFECTIONS IN OVERWEIGHT, OBESE AND GROSSLY OBESE INDIVIDUALS WHO ARE NON DIABETIC AND HIV NEGATIVE"** submitted by **Dr. RAJESH J,** appearing for part-II **M.D., Branch-I General Medicine** Degree examination in March 2008, is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulation of the Tamil Nadu Dr.M.G.R. Medical University, Chennai. I forward this to the Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India.

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## DECLARATION

I solemnly declare that the dissertation entitled "**A STUDY ON THE SPECTRUM OF VARIOUS INFECTIONS IN OVERWEIGHT, OBESE AND GROSSLY OBESE INDIVIDUALS WHO ARE NON DIABETIC AND HIV NEGATIVE**" is done by me at Madras Medical College and Government General Hospital, Chennai during 2006-2007 under the guidance and supervision of **Prof. D. Rajasekaran, M.D.,**

The dissertation is submitted to the Tamil Nadu Dr. M.G.R. Medical University towards the partial fulfillment of requirements for the award of M.D. Degree (Branch-I) in General Medicine.

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# CONTENTS

# INTRODUCTION

## BACKGROUND INFORMATION OF THE STUDY:

Obesity is a state of excess adipose tissue mass. Although often viewed as equivalent of increased body weight, this need not always be the case, as lean but very muscular individuals may be overweight by arbitrary standards without having increased adiposity. Obesity is therefore more effectively defined by assessing its linkage to morbidity or mortality[1].

The most widely used method to gauge obesity is the body mass index (BMI), which is weight in Kg/ Height $m^2$. Other approaches to quantify obesity include anthropometry (skinfold thickness), densitometry, computerised tomography or magnetic resonance imaging[1].

In Asians, the normal body mass index is 18-23. Over weight individuals have BMI of 23.1–28, obese individuals 28.1–33 and grossly obese individuals $\geq$33.1[2].

## LACUNA IN THE CURRENT KNOWLEDGE:

Obesity has a clear but not yet precisely defined effect on the immune response through a variety of immune mediators, which

leads to susceptibility to infections. Data on the incidence and outcome of specific infections, especially community - acquired infections, in obese people are so for limited. The available data suggest that obese people are more likely than people of normal weight to develop infections of various types[3]. Large prospective studies are required to further define the burden of infectious morbidity and mortality conferred by obesity.

**HYPOTHESIS:**

It has been recently recognised that the adipose tissue participates actively in inflammation and immunity, producing and releasing a variety of pro inflammatory and anti inflammatory factors, including the well studied adipokines leptin and adiponectin. Adiponectin is potently immunosuppressive[4], while leptin activates polymorphonuclear neutrophils[5], exerts proliferative and antiapoptotic activities on ‘T’ lymphocytes, affects cytokine production, regulates the activation of monocytes/macrophages and contributes to wound healing[6].

Leptin induction seems to be a protective component of the immune response and genetic leptin deficiency in human beings has been associated with increased mortality due to infections[7].

# AIMS AND OBJECTIVES

To study the spectrum of various infections in obese, over weight and grossly obese individuals who are non diabetic and HIV negative.

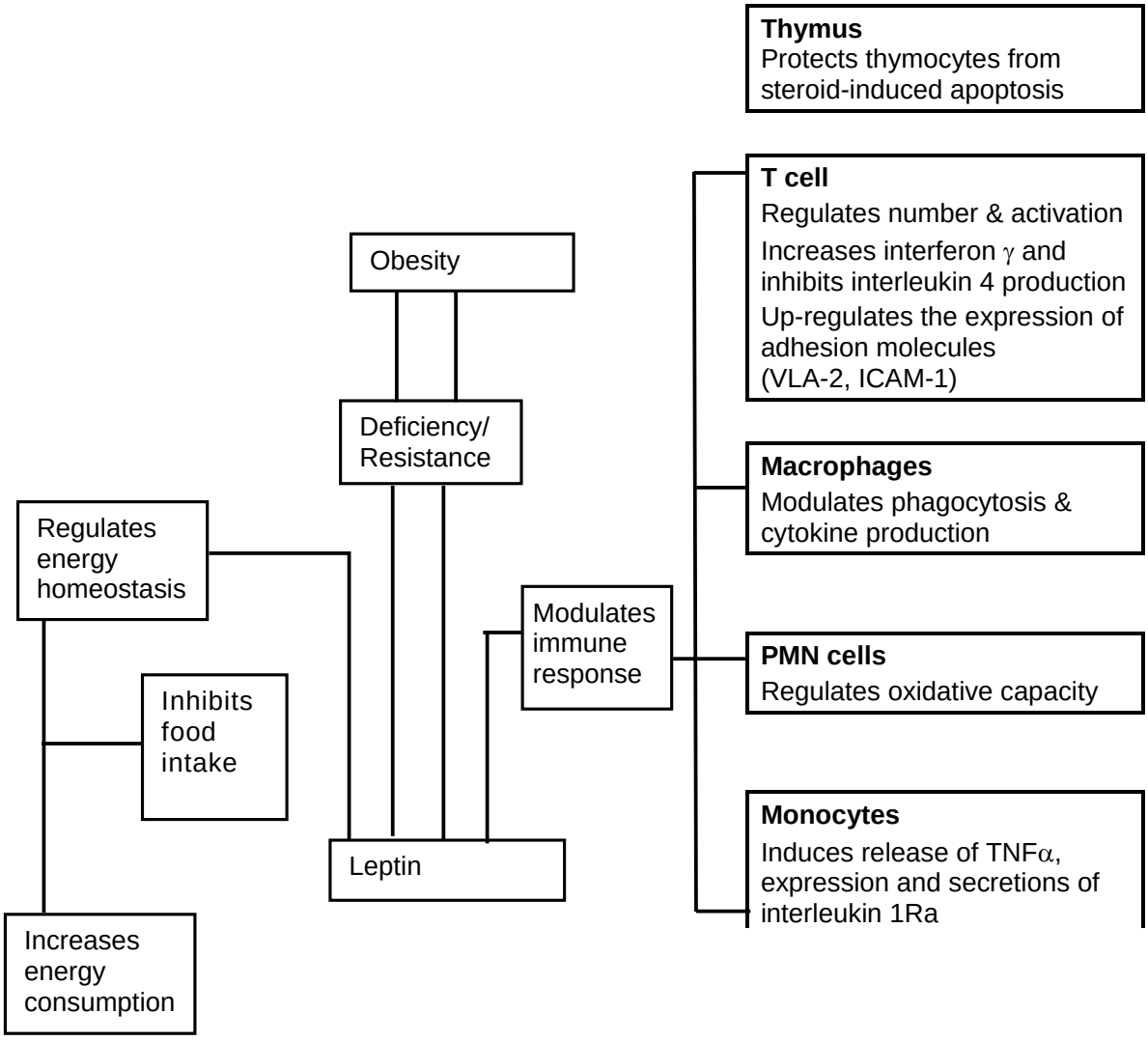
# REVIEW OF LITERATURE

## MECHANISMS THAT PREDISPOSE OBESE PATIENTS TO INFECTIONS:

Adipocytes participate in fatty acid composition and control of lipolysis. Prolonged low level immune stimulation induces hypertrophy of adipose tissue that partly emancipates the immune system from fluctuations in the abundance and composition of dietary lipids[8].

Increased susceptibility to infections in obese patients may be related to decreased availability of arginine and glutamine, resulting in decreased tumour necrosis factor production and increased nitric oxide release[9]. On the other hand, sepsis related morbidity in obese patients may reflect microvascular inflammation and thrombosis[10].

The connection of proinflammatory states of obesity with the risk of infection has not been precisely determined, but leptin seems to have an important role in the immune response. Leptin deficiency has been associated with susceptibility to infections in animals as well as in human beings. Additional research is needed to clarify whether various interventions such as weight loss, exercise, or nutrient supplementation could help to ameliorate the alterations in immunity of obese individuals[11].




**ROLE OF LEPTIN IN LINKING NUTRITIONAL STATE TO THE IMMUNE RESPONSE**

## NOSOCOMIAL INFECTIONS:

The incidence of nosocomial infections in overweight and obese patients is increased compared with normal weight patients. Obese patients may experience a prolonged length of stay, thus increasing their risk of acquiring a nosocomial infection[12-14]. Most available data concern obese surgical patients and reveal a high incidence of clinically relevant nosocomial infections such as pneumonia, wound infection, bacteremia and clostridium difficile colitis[15].

## SURGICAL SITE INFECTIONS:

Surgical site infections following various surgical procedures are more common in obese compared with non - obese patients[16]. Local changes such as an increase in adipose tissue, increase in local tissue trauma related to retraction, lengthened operative time, and disturbance of body homeostatic balance, may contribute to the increased incidence of surgical site infections caused by obesity[17.]

Subcutaneous tissue oxygenation is reduced in obese patients and this may predispose to wound infection, particularly after laparoscopic procedures[18]. Obesity was found to be

independently associated with staphylococcus aureus nasal carriage, which is a risk for surgical site infections[19]. Morbid obesity was recognised as an independent risk factor for surgical site infections after spinal surgery (laminectomy or spinal fusion)[20,21].

The incidence of mediastinitis as well as of deep and superficial sternal infection after coronary artery bypass grafting is increased in obese compared with normal weight patients[22-24]. In a large retrospective study of 22666 consecutive patients following CABG, the lowest risk for postoperative infection was recorded in patient with BMI between 26-27 $Kg/m^2$, whereas in overweight patients ($BMI \geq 28 Kg/m^2$) the risk was significantly raised ($P<0.01$)[25].

In addition, in an Australian large multicentre prospective study, obesity was found to be an independent predictor of surgical site infections following CABG conferring a higher risk even compared with diabetes mellitus (odds ratio 1.8 Vs 1.6 respectively)[26].

**ODONTOGENIC INFECTIONS:**

It has been reported that obesity is a predisposing factor for periodontal disease, especially among young individuals[27,28]. An association between high body weight and dental caries was

recorded even in elementary school children[29]. An experimental study found that there is a positive correlation between BMI and TNF-α concentration in gingival crevicular fluid of young individuals; these data imply that obesity may contribute to periodontal inflammation through a systemic effect[30].

**RESPIRATORY INFECTIONS:**

Obesity can profoundly alter lung mechanics, diminish exercise capacity, augment airway resistance, resulting in an increased work of breathing and influence respiratory muscle function, control of breathing and gas exchange. Moreover obesity is closely associated with obstructive sleep apnoea, a syndrome often accompanied by an increased risk of aspiration[31,32] as well as chronic inflammation of the upper and the lower respiratory tract[33,34].

The risk of aspiration pneumonia is increased in hospitalised obese compared with normal weight patients especially in the post operative period. This is postulated to be due to the higher volume of gastric fluid, lower pH of the gastric fluid in the fasting state, and higher incidence of gastro - oesophageal reflux in obese patients compared with normal weight patients[35,36].

## GASTROINTESTINAL, LIVER AND BILIARY INFECTIONS:

Obesity has been suggested to be associated with Helicobacter pylori colonisation[37], but in more recent reports, the observed difference did not reach statistical significance after adjustment for age[38].

Obesity is a well recognised risk factor for the development of steatosis in patients with chronic hepatitis-C infection and markers of obesity such as the BMI and waist to hip ratio correlate with the extent of steatosis in this population[39,40]. Steatosis is associated with decreased plasma adiponectin levels[41,42].

The degree of steatosis and fibrosis both tend to increase with increasing BMI, independently of the presence of diabetes mellitus. Hepatitis-C infection progresses more rapidly in obese compared with non - obese patients[43].

Obese patients are also at increased risk for biliary disease and its infectious complications both by being overweight and by reducing their body weight with extreme diets[44, 45].

The available data suggests that acute pancreatitis is more often complicated by infection in obese than non obese patients[46]. In a large cohort study comprising 10709 peritoneal dialysis

patients with a 12 year follow up, a higher BMI was associated with a shorter time to first peritonitis episode, independent of other risk factors (hazard ratio 1.08 for each 5Kg/$m^2$ increase in BMI, 95% CI 1.04-1.12, P <0.001)[47].

## UROGENITAL INFECTIONS:

The available data regarding urinary tract infections in obese patients mainly concern women, probably because of the increased incidence of urinary tract infections in this population. A study done in England and Scotland in the period of 1968-1974 to assess the possible association between various factors including obesity and urinary tract infections showed that the risk of first referral to hospital for a urinary tract infection decreased with age, while it was higher in non-obese than in obese women, in nulliparous compared with parous women, and in current users of the diaphragm compared with current users of other methods or no method of contraception[48]. The observed negative association between obesity and urinary tract infection was unexpected and independent of the effect of age, parity and diaphragm use. Many factors including the lesser probability of trauma to the genital area in obese females during intercourse has been postulated[49].

## SKIN INFECTIONS:

A higher incidence of cutaneous infections has been reported in obese compared with non-obese patients. Intertrigo, candidiasis, furunculosis, erythrasma, tinea crusis, and folliculitis are frequent skin infections among obese patients, while cellulitis, necrotising fasciitis, and gas gangrene are also occasionally encountered[50,51]. Fungal foot infections e.g. tinea pedis and toenail onychomycosis are more common in obese than non obese patients[52] and in the long run may predispose the affected patients to acute bacterial cellulitis of the lower extremitis[53]. Hidradenitis suppurativa is more prevalent in obese than normal weight patients[54].

Wound healing is partly regulated by leptin. Chronic wounds are associated with prolonged and dysregulated inflammation and decreased macrophage activation. Leptin is identified, through animal model study, as a potent mediator of keratinocyte proliferation during wound healing invivo. It may serve as a novel therapeutic factor to improve severely disturbed wound-healing conditions[55].

## BONE AND JOINT INFECTIONS

There are data suggesting that bone and joint infections can become rapidly progressive, involving adjacent structures and become life threatening in obese patients[56].

## OBESITY IN CRITICALLY ILL PATIENTS

Obese and morbidly obese patients in intensive care units are reported to have higher mortality compared with normal weight patients[57,58].

Obese patients have increased ICU related mortality explained by higher risk of sepsis, VAP and central venous catheter related infections[57].

The greater number of skin punctures during central venous catheter insertions, and in particular the extended duration of the presence of central venous catheters due to the difficulty in obtaining and maintaining peripheral venous access seem to account for the higher frequency of catheter related infections in obese critically ill patients[59].

## INFECTIONS IN PATIENTS WITH MALIGNANCY:

There are only a few reports regarding the influence of the body weight on the incidence of neutropenia related infections. A retrospective study of 768 children with acute myeloid leukemia compared survival rates in children, who were underweight, middle weight and overweight. It was shown that overweight children experienced excess treatment related mortality compared with middleweight ones (Hazard ratio 3.49, 95% CI 1.99-6.10, P<0.001). Mortality was particularly due to infections occurring after the first two courses of chemotherapy [60].

## POST-TRANSPLANT INFECTIONS:

Obesity seems to have an effect on the incidence of infections after solid organ or bone marrow transplantation. Pancreas grafts from obese donors are postulated to be more susceptible to ischaemia - reperfusion injury, resulting in abscess formation[61,62]. In addition, simultaneous pancreas and kidney transplantation in obese patients was associated with a significantly higher incidence of duodenojejunal leaks (P=0.012)[63].

Of interest, obesity appears to favour prognosis in recipients of allogenic stem cell transplantation. In a study of 544 patients

with haematological malignancies, it was observed that allogenic stem cell recipients with BMI under 20kg/$m^2$ had a higher incidence of streptococcal septicaemia (P=0.005) than patients with BMI of 20kg/$m^2$ or over[64].

## OBESITY AND HIV INFECTIONS:

The effects of obesity on immune function, disease progression and mortality were evaluated longitudinally in 125 HIV-1 seropositive drug users and 148 HIV-1 seronegative controls followed at a community clinic from 1992 to 1996, before the administration of highly active antiretroviral therapy (HAART). Over an 18 month period, atleast 25% decline in CD4 cell count was recorded in 60.5% of non obese HIV-1 seropositive patients compared with 18% of the obese patients, (P<0.004). The data suggests that mild to moderate obesity in HIV-1 infected chronic intravenous drug users favours survival[65].

## MANAGEMENT OF INFECTIONS IN OBESE PATIENTS:

Despite the growing prevalence of obesity worldwide, there are no well established guidelines about the management of infections in obese patients.

The pharmacokinetics of many antimicrobials, including vancomycin and aminoglycosides, appears to be altered in obese patients. Obese patients show increased volume distribution and clearance of vancomycin.

As far as the management of viral infections in obese individuals are concerned, obesity seems to influence not only the progression but also the response to treatment of hepatitis C.

Obesity seems to influence not only the progression but also the response to treatment of hepatitis C. Specifically, a BMI greater than 30 $Kg/m^2$ was found to be an independent negative predictor of response to treatment of hepatitis C infections[66].

# THE CONCEPT OF INFECTO OBESITY:

Obesity of infectious origin is a concept that has been studied in animal models. Several pathogens including canine distemper virus, Rous associated virus 7, Borna disease virus, scrapie agent and human adenoviruses Ad 36 and 37 have been implicated.[67,68] Canine distemper virus, a morbillivirus closely related to the human measles virus, was the first reported obesity promoting virus, leading to a significant increase in the body weight of the experimentally infected mice[69-71] ($P<0.001$).

# MATERIALS AND METHODS

## COLLABORATION DEPARTMENTS:

The prime department being the institute of internal medicine, Govt. General Hospital, Chennai, the present study is collaborated by the Department of biochemistry, Department of Microbiology and the Department of Dermatology, Govt. General Hospital, Chennai.

## ETHICAL APPROVAL:

The study has been duly approved by the Institutional Ethical Committee (IEC), during the IEC meeting.

## DESIGN OF THE STUDY:

The study conducted on the fifty patients was a prospective observational one. The subjects were classified as obese, overweight and grossly obese, based on the Asian criteria of body-mass index.

These patients, who got admitted in our hospital, with symptoms and signs conforming to one or more infections, were investigated accordingly and were assigned as infected patients when the due investigations came as positive.

## PERIOD OF STUDY:

The subjects for the present study comprised of the out-patient/ in-patients in Govt. General Hospital, and were studied over a period of 3 years.

## SAMPLE SIZE:

Fifty patients, who were either obese, overweight or grossly obese and who showed positivity to the infection/infections concerned, were included in the study.

## SELECTION OF STUDY SUBJECTS/MATERIALS:

The subjects for the concerned study were selected on a random basis, first being assigned as either obese, overweight or grossly obese according to the Asian criteria of body mass index.

The patients of the study were both males and females and were selected irrespective of age, socioeconomic status and cultural background. They were either those who got admitted with symptoms and signs, pertaining to one or more infections, or those who came to Govt. General Hospital, Chennai, outpatient department with symptoms and signs of infection who did not require admission, especially those with skin infections.

**INCLUSION CRITERIA:**

The subjects were included as the patients of study,

when they had a body mass index (BMI) of 23.1 to28, when they were assigned as overweight individuals, obese when their BMI was between 28.1 to 33 and grossly obese when their BMI was ≥33.1 and had one or more of the following.

i) Positive urine culture.

ii) Positive sputum culture & x-ray signs compatible with pneumonia and positive gram staining of sputum.

iii) Positive skin scrapings, typical skin lesion, positive fungal or bacterial culture of the concerned skin lesion.

iv) Positive pus culture of the limb cellulitis.

**EXCLUSION CRITERIA:**

Patients who are diabetic and HIV-infected were excluded from the study.

## DETAILS OF STUDY SUBJECTS:

A detailed clinical history was taken with special emphasis on the type and duration of the febrile illness, co-existing physical illness, patient's description of the skin lesion if any.

***Detailed examination of the patients was carried out including:***

- General physical examination - any evidence of anemia, fever, abdominal tenderness, inspection of the expectorated sputum, pulse rate, respiratory rate, blood pressure, and detailed examination of the skin lesion if any.

- Respiratory system was examined clinically for physical signs of pneumonia including impaired percussion note, bronchial breath sounds, pleural rub etc.

- Neurological examination was conducted in patients suspected to have sepsis for the assessment of the level of sensorium.

- All patients were investigated with complete hemogram including haemoglobin, total blood count,

differential count, erythrocyte sedimentation rate, blood sugar, renal function tests and HIV ELISA.

- Patients who had clinical signs of pneumonia were investigated with x-ray chest, sputum cytology, sputum gramstaining, sputum culture and sensitivity and blood culture and sensitivity.

- Patients whose symptomatology had a picture of urinary tract infection were investigated with routine urinalysis, urine culture and sensitivity and blood culture and sensitivity in addition.

- Patients who had skin infections alone, were investigated with gram staining of the skin scrapings, KOH mount examination, wood's lamp examination and skin culture and sensitivity depending upon the skin lesion.

- Patient who had features suggestive of ventilator - acquired pneumonia, were investigated with endotracheal tube culture (or) tracheostomy tube culture and new x-ray chest for the demonstration of the newly developed infiltrate, and blood culture & sensitivity.

- ❖ Patients with limb cellulitis were investigated with pus culture and blood culture & sensitivity.

**DEFINITIONS:**

***i) Community - Acquired pneumonia:***

It is defined as a constellation of symptoms and signs (fever, chills, cough, Pleuritic chest pain, sputum production, hyper or hypothermia, increased respiratory rate, dullness to percussion, bronchial breathing, egophony, crackles, wheeze, pleural friction rub) in combination with atleast one opacity on chest radiography, which is acquired from the community[72].

***ii) Ventilator acquired pneumonia:***

Is a subset of hospital acquired pneumonia that has been defined as pneumonia occuring after atleast 48 hours of mechanical ventilation and not incubating at the time of intubation[72].

***iii) Definition of urinary tract infection:***

Is defined as when pathogenic micro-organisms are detected in the urine, urethra, bladder, kidney or prostate. Arbitrarily, growth of $>10^5$ organisms per millilitre from a properly collected midstream “clean-catch” urine sample indicates infection[73].

In our study, only the uncatheterised patients, who are having symptoms and signs suggestive of urinary tract infection were taken into account and were assigned to have UTI, when the investigations proved positive, satisfying the above mentioned criteria.

***iv) Post partum UTI:***

Post partum UTI is defined as the urinary tract infection occuring with 6 weeks of delivery.

***v) Cellulitis:***

Defined as the infection of subcutaneous tissues.

***vi) Erythrasma:***

A superficial skin lesion characterised by the presence of reddish brown, scaly, pruritic, macular patches caused by corynebacterium minutissimum that exhibits coral red fluorescence under a Wood's light.

***vii) Intertrigo:***

An infection between skin surfaces, caused by friction, combined with moisture and warmth.

***viii) Hidradenitis Suppurativa:***

It is a recurrent follicular infections in regions such as axilla, most commonly caused by staphylococcus aureus.

**DEFINITION OF CLINICAL SIGNS:**

***Tachycardia:***

Arbitrarily defined as a pulse rate of >100 beats/min.

***Hypothermia:***

Defined by an unintentional drop in the body's core temperature below $35^0$C ($95^0$F).

***Hyperthermia:***

Is defined as an oral temperature of >$37.2^0$C or $98.9^0$F when measured A.M, and an oral temperature of >$37.7^0$C ($99.9^0$F), when measured P.M[74].

In menstruating women, the temperature was measured in the evening hours, as A.M. Temperature is generally lower in the 2 weeks before ovulation.

***Tachypnoea:***

Defined as a respirating rate of >24 min.

***Hypotension:***

Arbitrarily defined as systolic blood pressure of <90mmHg.

## DEFINITIONS OF THE MATERIALS (APPARATUS USED AND THE LABORATORY TESTS DONE)

***Wood's Lamp:***

It is an instrument which generates 360nm ultraviolet or "black" light used to evaluate certain skin lesions like erythrasma, tinea capitis, freckles and post inflammatory hyperpigmentation.

***Blood glucose estimation:***

Blood glucose was estimated by glucose-oxidase and peroxidase method.

Only patients with fasting blood glucose <110mg/dl (fasting is defined as absent caloric intake for atleast 8 hours) and 2 hrs post prandial blood sugar <140mg/dl, who are not on any drugs known to reduce blood sugar, are taken into consideration for the study.

***Positive sputum cytology:***

The sputum of the infected person, suspected to have pneumonia is subjected to cytology, which when showed >25 white blood cells and <10 squamous epithelial cells per low power-field is declared positive and is subjected to gram staining and culture.

***Sputum Gram staining:***

Done by standard technique.

***Sputum Culture & Sensitivity:***

The sputum of the patients, who had a clinical picture of pneumonia and whose sputum cytology showed positivity was subjected to culture & sensitivity. The sputum sample was inoculated in chocolate agar and incubated at $37^0$C in a candle jar with 8-10% $CO_2$. The period of incubation is 48 hours. The organisms were detected based on the colony colour produced.

Greyish white colonies are usually produced by E-coli, Klebsiella, Acinetobacter, Proteus and Pseudomonas. Organisms producing greyish white colonies are again subjected to lactose fermentation. While E-coli and klebsiella do ferment lactose, Pseudomonas, Proteus and Acinetobacter do not.

White opaque colonies are usually produced by staphylococci and streptococci. The colonies which produced colour change in cultures are again subjected to gram staining and standard identification techniques.

## BLOOD CULTURE AND SENSITIVITY:

Patients suspected to have had pneumonia, urinary tract infection and limb cellulitis underwent blood culture.

5ml of blood was collected under aseptic precautions and inoculated onto 50ml of Brain Heart infusion broth, which is the standard media used for blood culture. The broth was incubated at $37^0$C and subcultures were made at 24 and 48 hours, onto MacConkey blood agar and chocolate agar plates, and once again after 5 days, before being declared negative. Any growth was identified as per the standard protocol.

Greyish white colonies are produced by Klebsiella, Pseudomonas and Acinetobacter species. Whitish opaque colonies were produced by staphylococci, streptococci and coagulase negative staphylococci.

## URINE CULTURE AND SENSITIVITY:

The properly collected midstream “Clean catch” urine sample of the patients who had a clinical picture of urinary tract infection was inoculated onto Mac ConKey agar, which is the standard medium used. Urine sample with the medium is then incubated at

$37^0$ in air, and inspected at 24hrs. and 48hrs. Positive samples were then subjected to routine biochemical tests for identifications.

## MYCOLOGICAL INVESTIGATION INCLUDING KOH MOUNT AND CULTURE:

Skin scrappings were done from the suspicious skin lesion and subjected to KOH mount. Scrappings were examined under light microscope for hyphal elements and yeasts.

Saboraud's agar (or) SDA (Saboraud's Dextrose Agar) is the standard medium used for skin culture. The suspicious skin lesion sample was inoculated onto 2 tubes of SDA and incubated at $28^0$C. It was then inspected at 48hrs. then on alternate days for 1 week and then twice a week for 21 days before declaring as negative. Any growth found was subjected to gram staining and lactophenol cotton blue (LPCB) tests.

Candida albicans was identified by germ tube test and formation of chlamydospores.

## PUS CULTURE AND SENSITIVITY:

Pus from cellulitic lesion was incubated at $37^0$C Mac ConKey Agar in a candle jar in the presence of 8-10% $CO_2$ for 24-48 hours. The organisms are identified based on the colour of the colonies, which were again subjected to standard identification techniques.

# OBSERVATIONS AND RESULTS

**TABLE - I**
**GROUPING OF THE STUDIED PATIENTS**
**BASED ON AGE DISTRIBUTION**

| *S.No.* | *Age of Distribution* | *Number of Patients* | *Percentage* |
|---|---|---|---|
| 1. | 21 - 30 | 6 | 12% |
| 2. | 31- 40 | 8 | 16% |
| 3. | 41- 50 | 16 | 32% |
| 4. | 51 - 60 | 9 | 18% |
| 5. | > 60 Years | 11 | 22% |

Observed patients were grouped under five categories, based on their age distributions.

a) Patients between the age group of 41 - 50 years constituted the maximum number (32%)

b) Patients between 21-30 constituted 12%, between 31 and 40 ➔ 16%, 51 and 60 ➔ 18% and above 60 years constituted 22%

**TABLE - II**
**SEX DISTRIBUTION**

| *S.No.* | *Sex* | *Number of Patients* | *Percentage* |
|---|---|---|---|
| 1. | Males | 29 | 58 % |
| 2. | Females | 21 | 42% |

In our study, among 50 patients, 29 constituted males (58%) and 21 constituted females - 42%

**TABLE - III**
**PERCENTAGE DISTRIBUTION**
**ACCORDING TO BODY MASS INDICES**

| *S.No.* | *Body Mass index and the category* | *Number of Patients observed* | *Percentage* |
|---|---|---|---|
| 1. | Over weight (23.1–28) | 22 | 44% |
| 2. | Obese (28.1–33) | 24 | 48% |
| 3. | Grossly Obese ($\geq$33.1) | 4 | 8% |

When classified, based on the body mass index, obese patients with a BMI between 28.1 and 33 constituted the majority of 48%, overweight category patients with a BMI between 23.1 and 28 of 44% and grossly obese patients with a body mass index of $\geq$33.1 of 8%.

**TABLE - IV**
**DISTRIBUTION OF THE VARIOUS INFECTIONS AMONG THE TWO INDIVIDUALS SEXES ACCORDING TO THE BODY MASS INDEX**

| *S.No.* | *BMI Class and Sex* | *Number of Patients* | *Percentage* |
|---|---|---|---|
| 1. | Over weight males | 13 | 26% |
| 2. | Obese Males | 15 | 30% |
| 3. | Grossly Obese Males | 1 | 2% |
| 4. | Over weight Females | 9 | 18% |
| 5. | Obese Females | 9 | 18% |
| 6. | Grossly obese females | 3 | 6% |

a) The study saw obese males as the major component of about 30% of total, immediately followed by overweight males of 26%, a number of 13.

b) Overweight females and obese females, each occupied 18%.

c) Grossly obese males category gave the least contribution, with only one member found in the study group, the percentage of total being 2%.

d) Obese males were the highest in number in the male category as well as on the study as a whole.

e) Among females, there was an observed equal distribution among both overweight and obese categories, each - 18% of the total.

f) Grossly obese females were 6% of the total.

**TABLE - V**

**PERCENTAGE DISTRIBUTION OF THE VARIOUS INDIVIDUAL INFECTIONS OBSERVED AMONG THE PATIENTS**

| *S.No.* | *Type of Infection* | *Number of Patients* | *Percentage* |
|---|---|---|---|
| 1. | Lower limb cellulitis | 11 | 22% |
| 2. | Urinary tract infection | 12 | 24% |
| 3. | Community acquired pneumonia with and without positive blood culture | 7 | 14% |
| 4. | Ventilator acquired pneumonia with and without positive blood culture | 4 | 8% |
| 5. | Oral candidiasis | 3 | 6% |
| 6. | Candidal Glossitis | 2 | 4% |
| 7. | Intertrigo | 5 | 10% |
| 8. | Hidradenitis suppurativa | 4 | 8% |
| 9. | Erythrasma | 2 | 4% |

i) As per the data furnished in the above table, when considered as individual infections, URINARY TRACT INFECTION was found to be the commonest infection, amounting to a number of 12 and a percentage of 24% of the total.

ii) UTI was closely followed by lower limb cellulitis, accounting for 22% of total.

iii) Community acquired pneumonia with and without positive blood culture accounted for 14% and ventilator acquired pneumonia for 8%.

iv) Oral candidiasis amounted to 6% while candidal glossitis was 4% of the total.

v) Erythrasma was found only in 2 of the 50 observed patients, contributing to 4%.

vi) Intertrigo was found in 5 out of the 50 patients → 10% of the total.

vii) Hidradenitis suppurativa accounted to 8%.

***VI. When infections were systemically compartmentalised, picture was different-infections came under 4 categories:***

- ❖ Oral candidiasis, candidal glossitis, intertrigo, Hidradenitis suppurativa and erythrasma ➔ Dermatological infection.
- ❖ Urinary tract infection.
- ❖ Community acquired pneumonia & ventilator acquired pneumonia with and without positive blood culture ➔ Respiratory infection.
- ❖ Lower limb cellulitis.

**TABLE - 6**

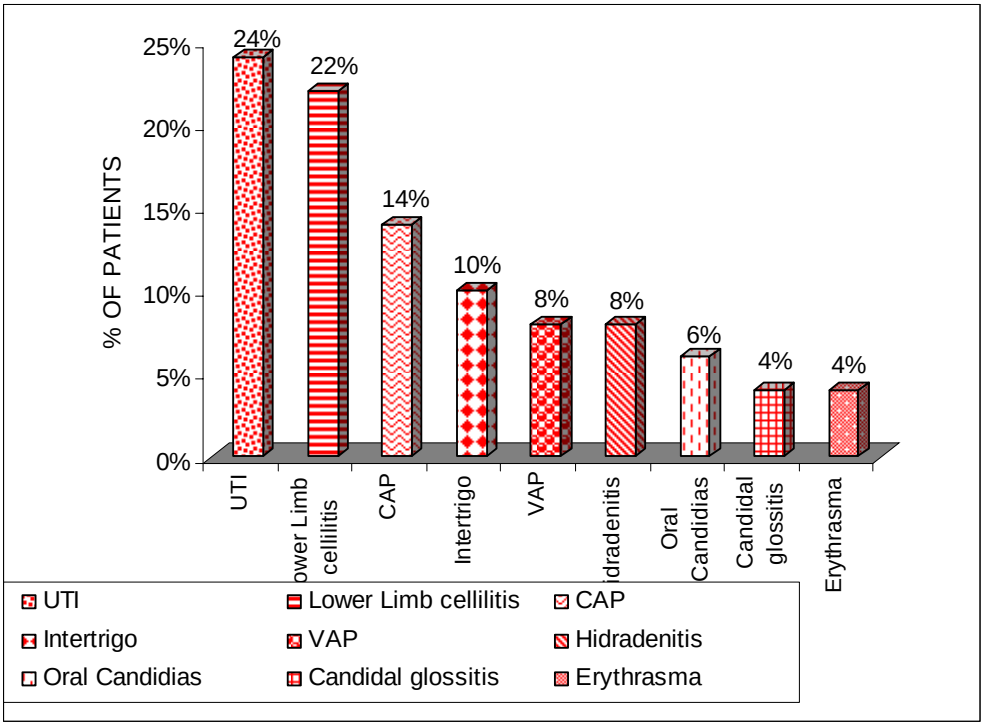
| *S.No.* | *Type of infection* | *Number of Patients* | *Percentage of the total* |
|---|---|---|---|
| 1. | Dermatological infections | 16 | 32% |
| 2. | Respiratory infections | 11 | 22% |
| 3. | Lower limb cellulitis | 11 | 22% |
| 4. | Urinary tract infection | 12 | 24% |

- ❖ When infections were systemically compartmentalised, **dermatological infections** topped the list, with 32% of the total.

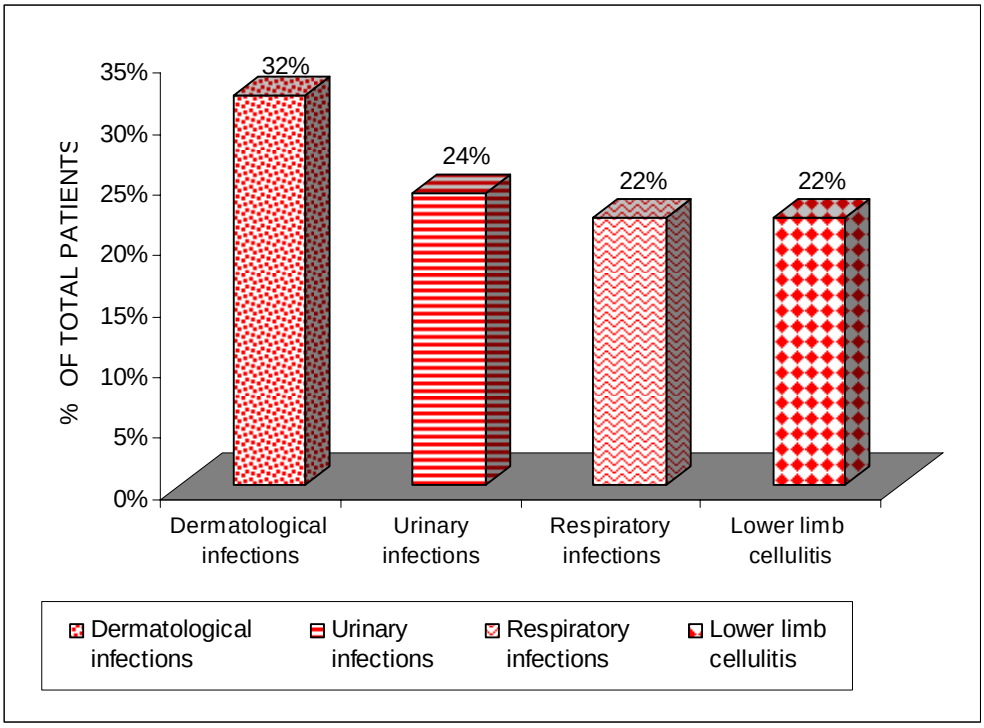
- Urinary tract infections followed the skin infections, with a contribution of 24%.

- Respiratory infections and lower limb cellulitis gave an equal contribution of 22% each.

## *VII. Bar diagram showing the percentage individual infections:*



## *VIII. Bar diagram showing the percentage of infections when they are compartmentalised systemically:*



## *IX. Distribution of infections among the various individual body mass categories:*

**TABLE - 7**

| *S. No.* | *Type of infection* | *BMI Class* | *No. of patients* | *% of total* |
|---|---|---|---|---|
| 1. | Dermatological infections | Over weight | 7 | 14% |
| | | Obese | 7 | 14% |
| | | Grossly obese | 2 | 4% |
| 2. | Urinary infections | Over weight | 7 | 14% |
| | | Obese | 5 | 10% |
| | | Grossly obese | 0 | 0% |
| 3. | Respiratory infections | Over weight | 4 | 8% |
| | | Obese | 7 | 14% |
| | | Grossly obese | 0 | 0% |
| 4. | Lower limb cellulitis | Over weight | 4 | 8% |
| | | Obese | 5 | 10% |
| | | Grossly obese | 2 | 4% |

- Of the observed dermatological infections, ( a total of 32%), there was an equal distribution among overweight and obese categories, each of 14%, and only two patients with dermatological infections, were grossly obese.

- ❖ When urinary tract infections are concerned, of the total contribution of 24%, majority were in the overweight category of about 14%, 10% were obese. No body was grossly obese.

- ❖ Of the 22% of the patients with lower limb cellulitis, 10% were obese, 8% overweight and 4% were grossly obese.

- ❖ Of the 22% of the patients who had respiratory infection, 14% were obese and 8% were overweight. None were grossly obese.

### *X. Distribution of the infections among males:*

**TABLE - 8**

| *Sex* | *No. of patients* | *% of Total* | *Individual infections* | *No. of patients* | *% of males with individ. infection* |
|---|---|---|---|---|---|
| M A L E | 29 | 58% | Dermatological infections | 11 | 22% |
| | | | Urinary tract infections | 5 | 10% |
| | | | Respiratory infections | 7 | 14% |
| | | | Lower limb cellulitis | 6 | 12% |

- Among males, **dermatological infections** superceded the other three with a score of 22% of the total or 37.93% of the male patients of the study.

- Respiratory infections amounted to 14% of the total or 24.13% of the male patients in the study.

- Lower limb cellulitis contributed 12% of the total or 20.68% of infected males of the study.

- 10% of infections of the total was UTI, (or) 17.24% of the infected males.

### *XI. Distribution of the infections among females:*

**TABLE - 9**

| *Sex* | *No. of patients* | *% of Total* | *Individual infections* | *No. of patients* | *% of females with individ. infection* |
|---|---|---|---|---|---|
| FEMALE | 21 | 42% | Dermatological infections | 5 | 10% |
| | | | Urinary tract infections | 7 | 14% |
| | | | Respiratory infection | 4 | 8% |
| | | | Lower limb cellulitis | 5 | 10% |

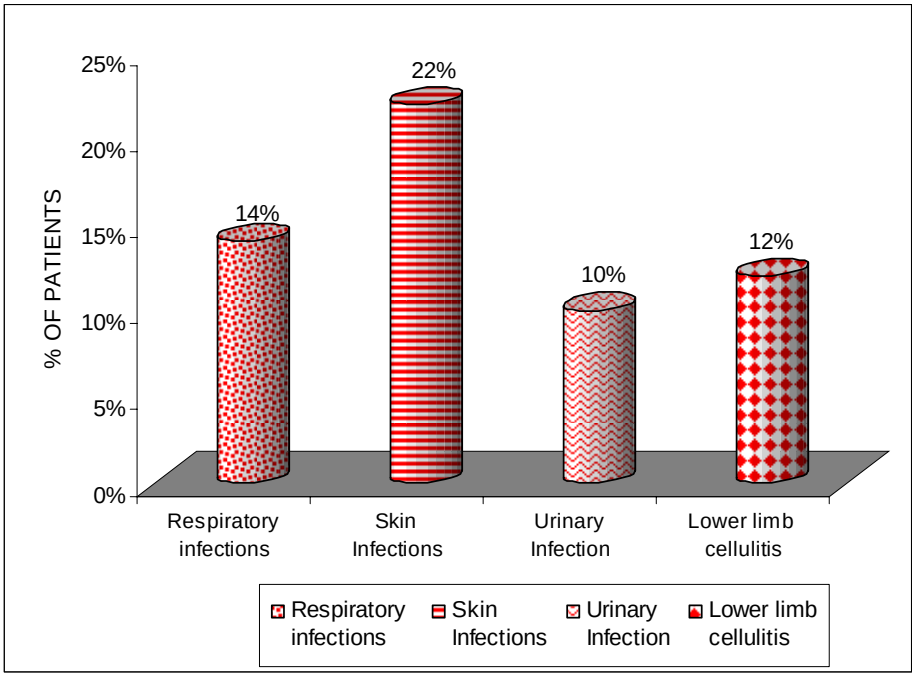
- When infected females of the study group were observed, **urinary tract infection** was found to be the commonest, with 14% of the total 50 patients, or 33.33% of the infected females.

- Skin infections contributed to 10% of the total (or) 23.8% of the observed females of the study.

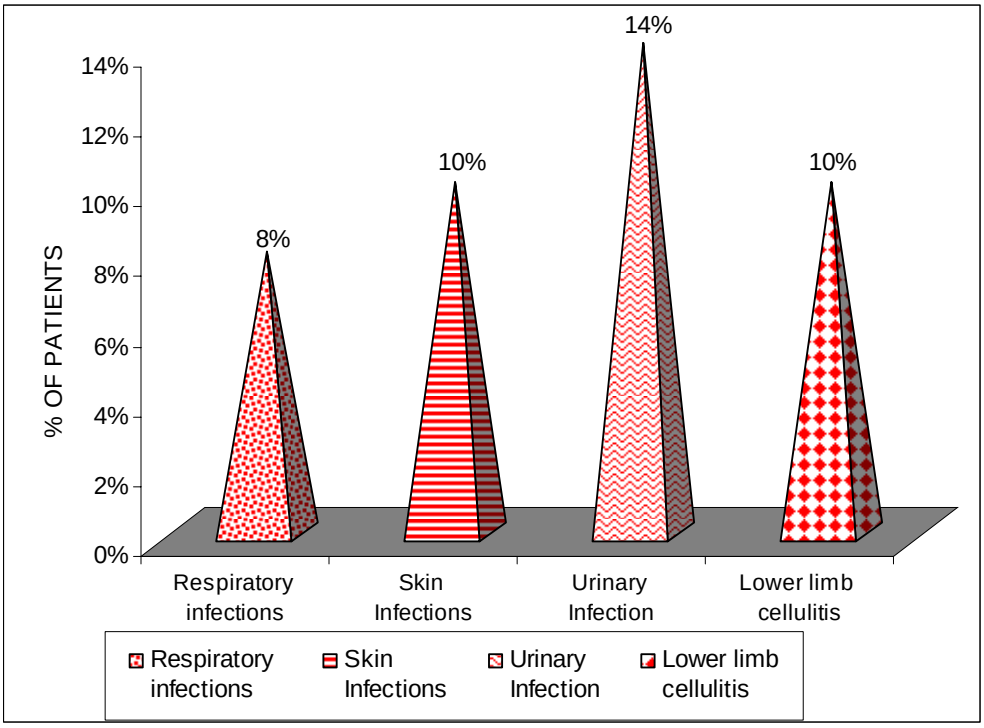
- Respiratory infections was 8% of the total or 19.04% of the infected females.

- Cellulitis of the lower limbs constituted 10% of the total (or) 23.8% of the females, observed in the study.

## *XII. Cylindrical diagram showing the infections among males:*



## *XIII. Pyramid diagram showing the infections among the observed females:*




Of the 7 females patients who had urinary tract infections, 5 patients were post partum, thus implying the fact, that post partum females with increased body mass index are more vulnerable to urinary tract infections.

***XV. Frequency of the various organisms encountered in the fifty patients of the study:***

| ***S.No*** | ***Type of the Organisms encounted*** | ***No.of patients*** | ***Percentage*** |
|---|---|---|---|
| 1. | E.Coli | 15 | 30% |
| 2. | Klebsiella | 5 | 10% |
| 3. | Candida Albicans | 10 | 20% |
| 4. | Proteus Mirabilis | 2 | 4% |
| 5. | Acinetobacter Acini | 1 | 2% |
| 6. | Streptococcus pneumoniae | 3 | 6% |
| 7. | Staphylococcus aureus | 10 | 20% |
| 8. | Enteric gram neg bacilli other than E.coli,Klebsiella and Pseudomonas | 1 | 2% |
| 9. | Pseudomonas | 1 | 2% |
| 10. | Corynebacterium minutissimum | 2 | 4% |

Of the ten different types of organisms encountered in the studied obese infected individuals, E.Coli constituted the majority, with 30%, followed by staphylococcus aureus and candida albicans, with an equal contribution of 20% each.

While Klebsiella had infected 5 patients, giving 10% of the total, proteus mirabilis and corynebacterium minutissimum had infected 8% of the individuals, 4% each.

Enteric gram negative bacilli, other than E.coli, Klebsiella and pseudomonas had infected only one individual, so also acinetobacter acini.

Streptococcus pneumoniae was encountered in 6% of the observed 50 patients.

# DISCUSSION

Our study made an emphasis on the various types of infections that could be encountered among obese individuals. Data available till now are so far limited regarding the incidence and outcome of specific infections in obese individuals and studies on large scale are needed to further define the problem.

## RESPIRATORY INFECTIONS:

In our study of 50 patients, 11 patients had respiratory infections accounting to 22% of the total. Of these, 14% of the patients had features compatible with community acquired pneumonia or 63.6% of the total respiratory infections encountered in the study.

A prospective study of age and life style factors in relation to community acquired pneumonia in United States, done on men aged 44-79 years from “Health Professionals follow-up study”[75] and women aged 27-44 years from “Nurses” Health study II[76], showed a direct association with an increased risk of community acquired pneumonia. They also observed a decrease in the risk of CAP with increasing physical activity among women.

- In our study, VAP constituted 8% of the infections in total or 36.4% of the respiratory infections observed in the study.

- A matched cohort study done by Yaegashi M, Jean R et al on the outcome of morbid obesity in ICU, among normal weight mechanically ventilated patients and obese with BMI > 30kg/$m^2$ mechanically ventilated patients, observed a higher risk of VAP in the latter.

**DERMATOLOGICAL INFECTIONS:**

In our study, as a whole, **dermatological, infections** were the commonest among the 50 patients, occuring in 16 patients, amounting to 32% of the total.

Of the 16 patients, 11 were male and 5 were female contributing to 37.93% of the infected males of the study and 23.8% of the infected females of the study.

But a study conducted by Muhammad Kurram, Saima Javed Paracha et al, on obesity related complications in 100 obese subjects between the age of 50-59 years of Rawalpindi, showed only 6 out of the 100 obese patients developing dermatological abnormalities including infectious and non infectious complications.

This was compared with 100 age matched controls, in which only 3 developed skin related abnormalities. The comparative study showed a ‘P’ value of 0.47, which was far from the significant range[77].

A prospective observational study of 330 patients with venous stasis leg ulcers showed that, patients who had a higher BMI showed poor healing of the ulcer[78].

So, our study demonstrated a higher percentage of dermatological infections which included candidiasis, hidradenitis, intertrigo and erythrasma, among the observed 50 patients.

**URINARY TRACT INFECTIONS:**

Our observations, regarding urinary tract infection was that, 24% of the total 50 patients had clinical symptoms, signs and culture proven infection. Of this 24% males contributed 10% and females contributed 14%, hence establishing that females are slightly more prone in conquering urinary tract infection than males.

Of the 7 observed females with UTI in our study, 5 were post partum, acquiring the infection within 42 days after delivery and only 2 females were outside the child bearing age.

MP Vessey, MA Metcalfe and K Mcpherson et al., from Department of Community Medicine, Radeliffe Infirmary Oxford, observed an unexpected negative association between obesity and urinary tract infection not explainable by age or parity. They observed and quoted that, the chance negative association could be due to lesser frequency of sexual intercourse and hence less likely trauma to genital area and the beneficial effect of increased oestrogenisation on the bladder and urethra of obese females, thus reducing the liability to infection.

In another large population based study conducted on nearly 60160 deliveries in wales, it was shown that post partum urinary tract infections were nearly twice more common in obese than non-obese women, with odd's ratio of 1.9 with 95% CL, 1.1–3.4[79]. This was in accord with and similar to our study's observation that post partum obese are more vulnerable to UTI.

**CELLULITIS:**

In our study, 11 patients had cellulitis primarily in the lower limbs, of which 6 were males (12%) and 5 were females (10%).

A study conducted by Thorstein dottir B, Tleyjeh IM, et al from department of medicine, in Mayo clinic observed that, obesity predisposes to lower limb cellulitis and abdominal wall cellulitis. They performed a retrospective database search to identify patients with cellulitis and morbid obesity who were seen at the Mayo clinic between 1998 and 2003. Of the 260 cases observed, 24 (9.2%) had morbid obesity and over two-thirds of them were females.

In our study regarding cellulitis, there was a slight male preponderance → 12% versus 10%.

# STUDY LIMITATIONS

1. The study done was a hospital based one and may not be representative of the general population.

2. The study was a prospective observational study on obese patients alone and not a comparative study between obese and non-obese.

3. Gastrointestinal infections, liver and biliary infections and surgical site infections were not included in the study.

4. Except diabetes mellitus and HIV infection, other comorbid conditions were not excluded from the study.

5. Study done was based on Asian Body Mass index criteria alone.

6. Personal habits of the patients including smoking and alcoholism were not taken into consideration.

# CONCLUSIONS

1. The most frequently observed infections in the studied obese, overweight and grossly obese individuals overall are those of **dermatological**, followed by urinary tract infections and cellulitis in that order.

2. Dermatological infections were the commonest among males.

3. Urinary tract infection was the commonest among females, with nearly 70% occuring in post partum.

4. The most frequently encountered organism is E.coli.

5. The question of whether the relation between obesity and infection is causal or simply an association generated by confounding factors such as diabetes cannot be easily answered.

# SCOPE FOR FUTURE STUDIES

Our study observed the spectrum of various infections that could occur in obese individuals. Studies that could be conducted in the future could define the real burden of infectious morbidity and mortality conferred by obesity, if they are conducted on a large prospective scale.

Relevant research efforts should also focus on obese children, where the available data are even more scarce compared with the adult population. Future studies should bring out prospective information regarding whether preventing and treating at least the related infectious morbidity would prove cost-effective.

Studies in the future may throw light on whether topical or systemic leptin administration in chronic wounds would accelerate healing and limit bacterial colonisation and infection.

Additional researches may enlighten whether weight loss and exercise may help in augmenting the deficient immunity in obese individuals.

# PROFORMA

To study the spectrum of various infections in overweight, obese and grossly obese individuals who are non diabetic and HIV negative.

**IN ASIANS**

a) Normal BMI : 18 to 23

b) Overweight : 23.1 to 28

c) Obese : 28.1 to 33

d) Grossly Obese : ≥33.1

## I) GENERAL DATA

1) Name

2) Age

3) Sex

4) IPNo

5) Weight in Kg

6) Height in m

7) BMI (wt. in kg/Ht in m2)

8) Class of the individual based on the body mass index : Overweight/Obese/Grossly Obese

9) Fasting blood sugar

10) 2hr post prandial blood sugar

11) Glycaemic status

12) HIV ELISA

13) HIV STATUS

## II. DATA ON INDIVIDUAL INFECTIONS

***a) Respiratory Infections:***

i) Principle Symptoms

ii) Physical Signs

iii) X-ray Chest PA view

iv) Sputum Culture & Sensitivity: Positive/Negative

v) Organism grown on sputum

vi) Sputum organism sensitive to:

vii) Blood culture and sensitivity : Positive/Negative

viii) Organism grown in blood culture:

ix) Blood organism sensitive to:

***c) Skin Infections***

i) Clinical diagnosis of skin infection

ii) KOH mount

iii) Woods lamp examination

iv) Specific investigation if any

***d) Urogenital Infection***

i) Symptoms:

ii) Signs:

iii) Urine routine analysis:

iv) Urine C&S:

v) Organism cultured from Urine:

iv) Organism sensitive to:

***f) Infections in critically ill patients:***

i) Symptoms :

ii) Signs :

iii) X-Ray chest :

iv) USG abdomen :

v) Blood C&S : Pos/Neg

vi) Organism isolated from Blood :

vii) Blood organism sensitive to :

viii) Urine C&S : Pos/Neg

ix) Organism isolated from Urine :

x) Urine organism sensitive to :

xi) ET tube (or) Tracheostomy tube culture: Pos/Neg

xii) Organism isolated :

xiii) Organism sensitive to :

xiv) Catheter site C&S : Pos/Neg

xv) Organism isolated and its sensitivity :

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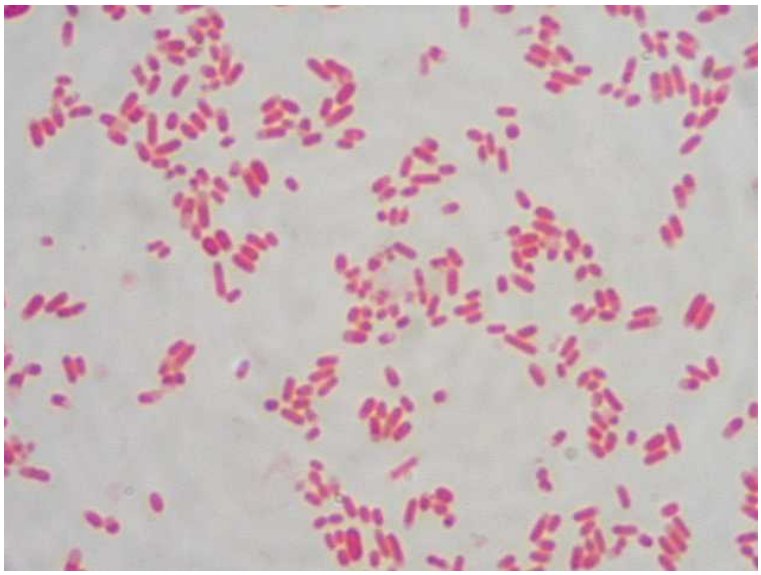
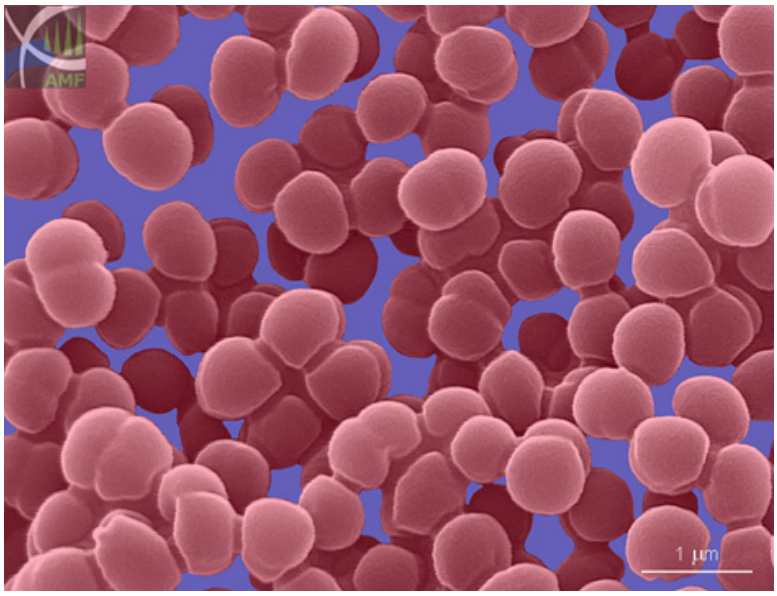
# ABBREVIATIONS

| | |
|---|---|
| BMI | - Body Mass Index |
| UTI | - Urinary Tract Infection |
| CAP | -Community Acquired Pneumonia |
| VAP | - Ventilator Acquired pneumonia |
| KOH Mount | - Potassium Hydroxide Mount |
| SDA | - Saboraud’s Dextrose Agar |
| LPCB | - Lacto Phenol Cotton Blue |

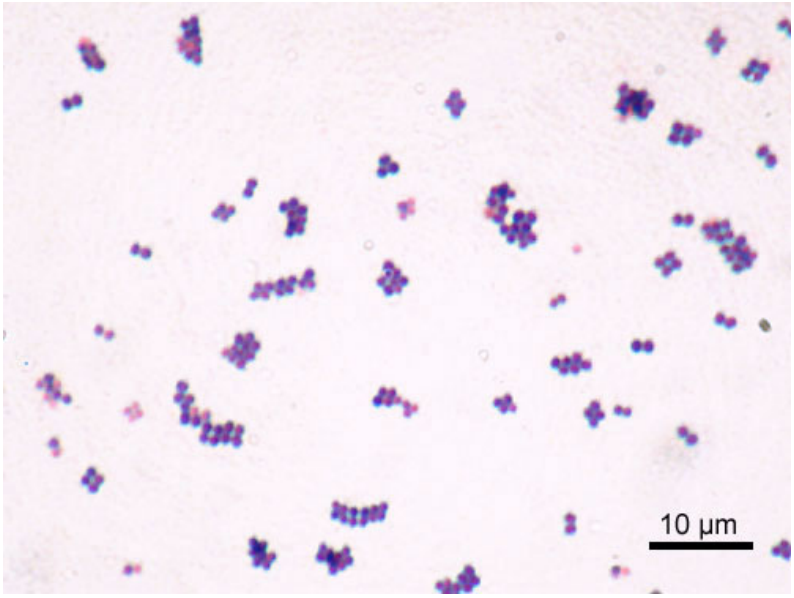
Pseudomonas Aeroginosa - the rod with characteristic single polar flagellum



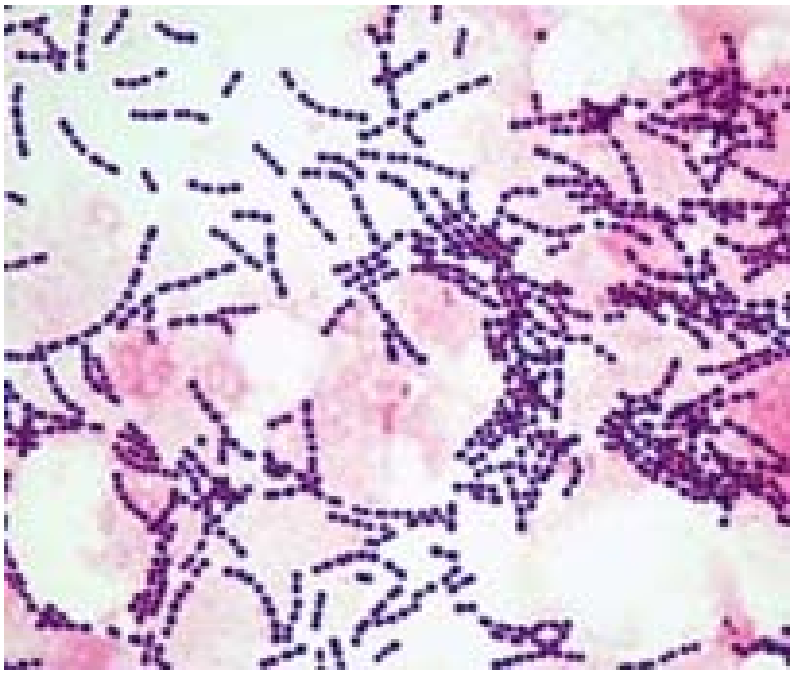
Escherichia coli



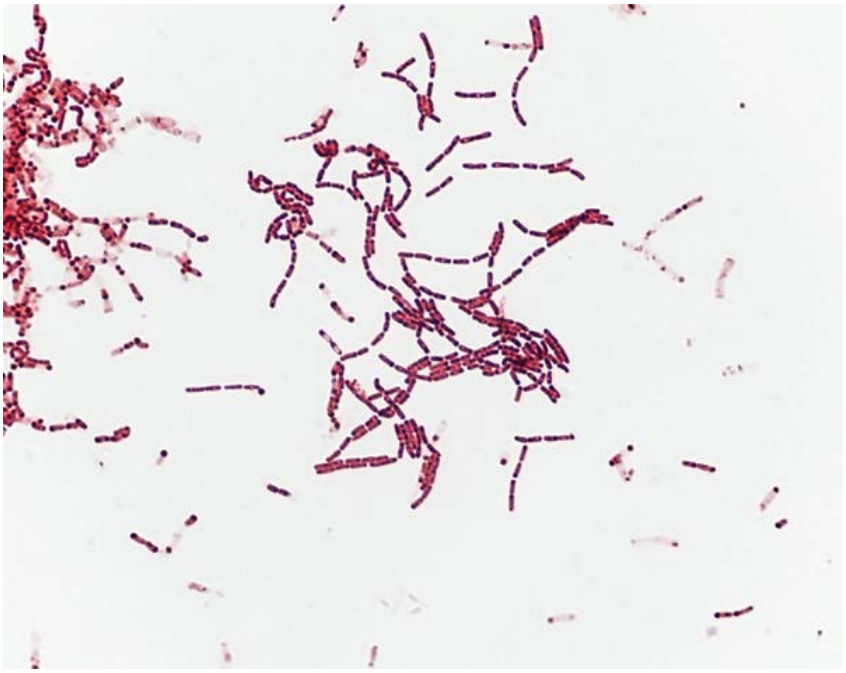

10b-Staphylococcus aureus under electron microscope




Large gram positive staphylococci in clusters



Elongated gram positive Streptococci in pairs and chains



Klebsiella Pneumoniae


Chlamydospores and Pseudohyphae of candida albicans

Candidal Glossitis in an  obese female

Oral Candidiasis in a female patient of our study

CAP in an Obese Patient in the study