"ASSOCIATION BETWEEN ACNE VULGARIS AND BODY MASS INDEX IN ADULT POPULATION: A TERTIARY HOSPITAL-BASED PROSPECTIVE STUDY IN NORTH KARNATAKA, INDIA"

Submitted By

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UNDER THE GUIDANCE OF

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LIST OF ABBREVIATIONS

ANOVA - Analysis of Variance
BMI - Body Mass Index
CASS - Comprehensive Acne Severity Scale
CI - Confidence Interval
C. acnes - Cutibacterium acnes (formerly Propionibacterium acnes)
DHT - Dihydrotestosterone
DEXA - Dual-Energy X-Ray Absorptiometry
GAGS - Global Acne Grading System
IGF-1 - Insulin-like Growth Factor-1
IGA - Investigator's Global Assessment
IL - Interleukin
mTORC1 - Mammalian Target of Rapamycin Complex 1
OR - Odds Ratio
PCOS - Polycystic Ovary Syndrome
ROC - Receiver Operating Characteristic
SD - Standard Deviation
SHBG - Sex Hormone-Binding Globulin
SPSS - Statistical Package for Social Sciences
TNF-α - Tumor Necrosis Factor Alpha
VAI - Visceral Adiposity Index
WC - Waist Circumference
WHO - World Health Organization
WHR - Waist-to-Hip Ratio
WHtR - Waist-to-Height Ratio

ABSTRACT

Introduction: Acne vulgaris affects pilosebaceous units, manifesting as comedones, papules, pustules, and nodules. While primarily affecting adolescents, it's prevalence may continue into adulthood. Beyond cosmetic concerns, acne significantly affects psychological wellbeing and quality of life. Its pathophysiology involves four key factors: increased sebum production, abnormal follicular keratinization, Cutibacterium acnes colonization, and inflammation. Androgens play a crucial role, but modern research recognizes additional influences including diet, genetics, environment, and metabolism, establishing acne as a complex, multifactorial condition. A possible relationship between adult acne severity and body mass index has been explored in recent studies.

Aims and objectives: We sought to assess the impact of body mass index on severity of acne.

Materials and methods: In this single centre prospective case-control study 312 acne cases and 312 age-matched controls were included, and their body mass index were also calculated according to WHO and Asian classification. Patients and controls above 18 years of age who were age and gender-matched, presenting to the Department of Dermatology, Shri BM Patil Medical College Hospital and Research Center, Vijayapura were included in the study.

Results: The mean age of cases was 23.08 years, while that of controls was 25.03 years. A majority of the cases (60.3%) belonged to the younger age group (≤22 years). Additionally, there was a female predominance, with a female-to-male ratio of 1.35:1. There was no statistically significant difference between BMI of males and females. On comparing the mean BMI, it was

lower in cases (21.659) than in controls (22.294) ($p = 0.032$), indicating that acne cases tend to have slightly lower BMI.

Limitations: Dietary and lifestyle factors were not recorded.

Conclusions: This study provides novel evidence of an inverse relationship between BMI and both acne prevalence and severity in an adult population from North Karnataka, India.

Keywords: BMI, acne, acne vulgaris, adults, body mass index, epidemiology

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INTRODUCTION

Background on Acne Vulgaris as a Common Dermatological Condition

Acne vulgaris is a skin disorder mainly affecting the pilosebaceous units, presenting in forms ranging from mild comedonal lesions to severe inflammatory lesions. While it can occur across all age groups, its prevalence peaks during adolescence.[1] The global prevelance of acne is estimated to be approximately 9% of the global population. [2]

This is an inflammatory disorder of chronic nature in which development of comedones, papules, pustules, nodules, and potential scarring.[3] While often considered primarily a cosmetic concern, acne's impact extends far beyond appearance, with documented effects on psychological wellbeing, social functioning, and quality of life.

The pathophysiology of acne involves a complex interplay of four primary factors: increased sebum production, follicular keratinization, increased proliferation of Cutibacterium acnes (formerly P.acnes), and inflammation.[3] Hormonal influences, particularly androgens, play a crucial role in stimulating sebaceous gland activity and altered keratinization patterns. Recent research has expanded our understanding to include additional factors such as diet, genetic predisposition, environmental triggers, and metabolic influences—suggesting that acne is better understood as a multifactorial condition rather than simply a disease of adolescence or follicular dysfunction.[4]

Epidemiology of Acne in Adult Population

While acne commonly occurs in adolescent age group, epidemiological studies have demonstrated the significant prevalence of acne in adults, particularly among women.[5] Adult acne, defined as acne occurring after age 25, affects women more commonly than men. Adult acne presents with distinct clinical patterns compared to adolescent acne, with a predilection for inflammatory lesions in the lower face, jawline, and neck.

Persistent adult acne refers to adolescent acne that continues beyond the age of 25, while late-onset adult acne describes acne that first appears after this age. Both conditions exhibit distinct pathophysiological mechanisms and treatment responses.[6] The chronic, relapsing nature of adult acne contributes substantially to its burden, with studies indicating that

approximately 20% of adults continue to experience active acne into their thirties and beyond.[7]

Beyond its physical manifestations, acne carries significant psychosocial implications. Individuals often experience heightened self-consciousness, social withdrawal, anxiety, depression, and, in severe cases, suicidal thoughts. [8]

In the Indian context, epidemiological data suggest varying prevalence rates across different regions, with some studies reporting adult acne prevalence rates of 12-18% among urban populations and slightly lower rates in rural areas.[9] However, comprehensive epidemiological studies specific to adult populations in South India, particularly Karnataka, remain limited.

Overview of BMI Classifications (WHO and Asian-Pacific)

Body mass index (BMI) is recorded as weight in kilograms divided by height in meters squared (kg/m²), serves as a widely utilized screening tool for categorizing weight status. The World Health Organization (WHO) established international classification standards with underweight defined as BMI <18.5 kg/m², normal weight as 18.5-24.9 kg/m², overweight as 25.0-29.9 kg/m², and obesity as ≥30.0 kg/m².[10]

However, mounting evidence suggests that these standard WHO cutoffs may not accurately reflect health risks for Asian populations.[11,12] Research demonstrates that Asians have higher body fat at lower BMI values compared to Caucasians, resulting in elevated metabolic and cardiovascular risks at BMI levels considered "normal" by WHO standards. In response, the WHO Western Pacific Regional Office proposed modified BMI categories for Asian populations: underweight (<18.5 kg/m²), normal (18.5-22.9 kg/m²), overweight (23.0-24.9 kg/m²), and obese (≥25.0 kg/m²).[13]

These differing classification systems have significant implications for research and clinical practice, particularly when investigating conditions potentially linked to adiposity. In the Indian context, where obesity patterns and associated health risks differ from Western populations, the choice of BMI classification system may substantially impact epidemiological assessments and clinical decision-making.

Potential Pathophysiological Links Between BMI and Acne

Several biological mechanisms potentially explain the relationship between elevated BMI and acne pathogenesis. Adipose tissue functions as an active endocrine organ, producing hormones and inflammatory mediators that may influence acne development and severity through multiple pathways:

1. **Insulin resistance and hyperinsulinemia**: Higher BMI correlates with insulin resistance, leading to compensatory hyperinsulinemia. Elevated insulin cause increased production of androgen resulting in decrease sex hormone-binding globulin (SHBG) and increased androgen levels. [14] Androgens directly stimulate sebaceous gland activity and alter follicular keratinization.[15]

2. **Increased IGF-1 signaling**: Obesity and higher BMI are associated with increased insulin-like growth factor-1 (IGF-1) levels, which promotes sebaceous gland hyperplasia, sebum production, and keratinocyte proliferation—all key factors in acne pathogenesis.[16]

3. **Systemic inflammation**: Adipose tissue in people with BMI in category of overweight or obese causes increase in cytokines like TNF-α, IL-1β, and IL-6, which promote inflammation, creating a state of chronic low-grade inflammation that may exacerbate the inflammatory component of acne.[17]

4. **Altered dietary patterns**: Individuals with higher BMI often consume diets with higher glycemic loads and dairy products, both implicated in acne pathogenesis through insulin/IGF-1 signaling pathways and mTORC1 activation.[4,18,19]

5. **Lipid metabolism abnormalities**: Obesity alters sebum composition, potentially increasing the proportion of pro-inflammatory lipids that contribute to acne development.

Despite these plausible biological mechanisms, clinical evidence establishing a direct relationship between BMI and acne has been inconsistent, with some studies showing positive correlations while others demonstrate no significant association.

Significance of Studying This Correlation in North Karnataka Population

North Karnataka represents a unique demographic and geographical context for investigating the BMI-acne relationship for several reasons:

1. **Distinctive dietary patterns**: The traditional Karnataka dietary pattern, characterized by low glycemic index grains, anti-inflammatory spices (turmeric), probiotic-rich fermented foods, and specific cooking oils (coconut, groundnut), may significantly modify the established BMI-acne relationship when compared to Western populations. Understanding these region-specific dietary influences is crucial for accurately interpreting BMI-acne correlations in this population.

2. **Genetic considerations**: In South Indian populations, genetic factors create a distinct context for investigating the BMI-acne relationship. This demographic's unique genetic admixture of Ancestral North Indians (ANI) and genetically distinct Ancestral South Indians (ASI) influences both adiposity patterns and inflammatory responses. Interestingly, common leptin gene polymorphisms are highly predictive of obesity in South Indians,[20] with leptin functioning as a crucial molecular mediator between BMI and acne severity through multiple mechanisms: stimulation of sebaceous gland lipogenesis, promotion of inflammatory cytokine production, and enhancement of keratinocyte proliferation leading to follicular hyperkeratinisation.[21] These population-specific genetic factors may account for differential findings in BMI-acne correlation studies when compared to Western populations.

3. **Changing lifestyle patterns**: North Karnataka, like many regions in India, is experiencing rapid urbanization and lifestyle transitions, with increasing prevalence of sedentary behaviours, processed food consumption, and obesity—creating an optimal context for examining emerging relationships between metabolic factors and dermatological conditions.[22]

4. **Limited healthcare resources**: Understanding the relationship between BMI and acne could inform resource allocation in regions with limited dermatological care, potentially identifying high-risk individuals who would benefit from targeted interventions.

5. **Climate considerations**: The hot, semi-arid climate (low rainfall, hot summers, and relatively mild winters) of North Karnataka may interact with BMI-related factors like sweating patterns and skin microbiome composition, potentially modifying the BMI-acne relationship.[23]

Gap in Literature Regarding BMI-Acne Relationship in South Asian Populations

Despite the established biological plausibility of a relationship between body mass index and acne vulgaris, significant knowledge gaps exist in understanding this association within South Asian populations. Current literature demonstrates a notable underrepresentation of South Asian individuals in BMI-acne research, despite their distinctive adiposity distribution patterns and unique metabolic risk profiles compared to other ethnic groups.[20,21]

The appropriate BMI classification system for South Asian populations in acne research remains uncertain, as few studies have compared the predictive utility of standard WHO classifications versus Asian-specific BMI cutoffs. Furthermore, existing research has predominantly focused on adolescent populations, with insufficient attention to adult acne despite its considerable prevalence and psychosocial burden. The correlation between BMI and specific acne severity grades, rather than merely presence or absence of acne, remains inadequately investigated—a critical gap with important implications for clinical management.

India's significant regional heterogeneity in genetics, dietary patterns, and lifestyle factors necessitates region-specific investigations, as findings from one geographical area may not be generalizable to others.[24] Additionally, the specific pathophysiological mechanisms linking BMI and acne in South Asian populations remain poorly elucidated, potentially differing from other ethnic groups due to variations in metabolic profiles and inflammatory responses. The present study addresses these critical knowledge gaps by investigating the relationship between BMI (using both WHO and Asian-specific classifications) and acne severity in an adult population from North Karnataka, thereby contributing novel insights into the complex interplay between metabolic parameters and dermatological health in South Asian adults.

AIMS AND OBJECTIVE OF THE STUDY:

To study correlation between severity of acne and body mass index in the adult population of a tertiary care hospital in North Karnataka, India.

Review of Literature:

Acne vulgaris represents a complex, inflammatory disease multifactorial in nature affecting the pilosebaceous unit.[25,26] Acne vulgaris represents the prototypical form, characterized by open and closed comedones alongside inflammatory papules, pustules, nodules, and cysts affecting predominantly the face, back, and chest. Its pathogenesis involves increased androgen-mediated sebum production and the role of Cutibacterium acnes (formerly Propionibacterium acnes). Understanding its pathophysiology is crucial for appreciating the potential links with metabolic factors such as BMI.

HISTORY

Acne vulgaris, commonly known as acne, has been recognized and documented throughout human history. Ancient Egyptian records indicate that even pharaohs suffered from this skin condition. This was evident from the anti-acne remedies found in his tomb.[27]

Hippocrates and Aristotle were among the Greek physicians who reported a skin ailment known as *akmḗ*, which translates to "facial eruption" and subsequently became *akne*. Plant medicines combined with honey, which has antibacterial, anti-inflammatory, and exfoliating qualities, were frequently used to treat it.[28]

In Ebers Papyrus the word ‘aku-t’ is cited that was later translated as ‘boils, blains, sores, pustules or any inflammatory. In 1840, German dermatologist Heinrich Fuchs introduced the term "acne vulgaris" to describe common acne, distinguishing it from other skin conditions.[29]

Two years later, in 1842, British dermatologist Erasmus Wilson further refined this classification by separating "acne simplex" (now known as acne vulgaris) from "acne rosacea," recognizing them as distinct conditions.[30]

The early 20th century saw advancements in identifying the causes of acne. In 1900, American dermatologist Thomas C. Gilchrist conducted extensive studies on the bacteriology and microscopy of over 300 skin lesions, contributing to understanding acne’s etiology by identifying the presence of a rod shaped bacilli and named it Bacilli acnes.[31]

These historical milestones have paved the way for modern dermatology's approach to diagnosing and treating acne vulgaris, transforming it from a misunderstood ailment into a manageable skin condition.

A relatively recent development in dermatological research is exploring a potential link between body mass index (BMI) and acne vulgaris.[32–34] Historically, acne was primarily attributed to factors such as hormonal fluctuations, genetic predisposition, and bacterial activity.[35,36] The consideration of BMI as a contributing factor emerged as global obesity rates increased, according to a 2022 update reported by Boutari et.al., prevalence of obesity has increased from 4.6%1980 to 14.0% in 2019.[37] These current findings are prompting researchers to investigate how excess body weight might influence various health conditions, including skin disorders like acne.

In the early 21st century, studies examined the correlation between BMI and acne severity. For instance, a cross-sectional study conducted by Podder et.al., 2021 aimed to explore the prevalence of MetS in patients with acne.[38]

Despite these efforts, findings have been inconsistent. Some research suggests a correlation between higher BMI and increased acne severity, meanwhile other studies find no significant association. These mixed results highlight the complexity of acne pathogenesis and suggest that BMI is just one of many factors that may influence the condition.[26,39]

In summary, the historical perspective on acne vulgaris has evolved to include considerations of BMI, reflecting broader trends in public health and a more comprehensive approach to understanding and managing acne.

Epidemiology:

Acne vulgaris represents one of the most prevalent dermatological conditions in India, affecting approximately 50-80% of adolescents and young adults across various regions of the country as demonstrated in a clinic-epidemiological study by Khunger & Kumar in 2012.[40] The epidemiological profile of acne in Indian populations exhibits distinct characteristics regarding age of onset, gender distribution, clinical presentation, and potential triggering factors. Recent multi-center studies have documented peak incidence in the 16-20 age group, with persistence into adulthood becoming increasingly recognized, particularly among females.[41] A comprehensive review of hospital-based studies from diverse

geographic regions across India revealed significant urban-rural disparities, with higher prevalence in urban population compared to rural communities, suggesting potential environmental and lifestyle influences on acne pathogenesis.[42]

The Indian context presents unique epidemiological considerations including specific genetic predispositions, dietary patterns, environmental factors, and socioeconomic determinants that collectively shape acne presentation.[4,22,24,43] Notably, post-inflammatory hyperpigmentation occurs with greater frequency and severity in Indian patients compared to Caucasian counterparts, representing a significant concern due to its psychological impact and therapeutic challenges.[44] Studies examining anthropometric correlations have yielded variable results, with some investigations demonstrating associations between body mass index (BMI) and acne severity that differ from Western populations, potentially reflecting distinct metabolic profiles and body composition characteristics in South Asian individuals.[45]

Additionally, recent epidemiological surveys have highlighted the increasing prevalence of adult-onset acne among Indian women, particularly in the 25-40 age group, with potential associations to hormonal imbalances, occupational stress, and cosmetic product usage.[46]

Regional variations in acne epidemiology within India warrant consideration, as multiple studies have documented differences in prevalence and severity patterns across the country's diverse geographic and cultural landscape. Research from southern India reported higher prevalence rates among adolescents, with familial history identified as a significant risk factor.[47] Comparatively, studies from northern regions demonstrated slightly lower prevalence ranges but higher rates of inflammatory lesions, potentially attributable to climatic variations and dietary differences.[48] These epidemiological observations underscore the importance of population-specific research approaches when investigating acne pathogenesis, especially when examining anthropometric correlations and metabolic parameters in Indian patients, where ethnicity-appropriate reference ranges and classification systems should be employed.[12]

Pathophysiology of Acne Vulgaris

The pathogenesis of acne is predicated on four cardinal mechanisms: (1) follicular hyperkeratinization, (2) sebaceous gland hyperactivity with consequent hyperseborrhea, (3) Cutibacterium acnes colonization and proliferation, and (4) perifollicular inflammatory processes.[3]

Follicular Hyperkeratinization

The initial event in comedogenesis involves aberrant keratinocyte proliferation and differentiation within the follicular infundibulum. This dysregulation results in the retention of corneocytes within the follicular canal rather than their normal exfoliation to the skin surface. Androgen-mediated signals, particularly dihydrotestosterone (DHT), augment this process by upregulating keratin expression and promoting abnormal desquamation as elucidated by Zouboulis et.al.,[49] The accumulation of these hyperkeratotic cells, combined with sebum, forms the microcomedo—the primordial acne lesion that precedes all visible manifestations.

Sebaceous Gland Hyperactivity

The sebaceous glands, integral components of the pilosebaceous unit, undergo significant hyperplasia and increased functional activity during adolescence under androgenic stimulation. The sebocyte enzyme 5α-reductase transforms testosterone into its metabolite, DHT. DHT binds to nuclear androgen receptors, triggering transcriptional activation of genes involved in sebaceous lipogenesis.

Human sebum comprises a mixture of lipids like esterified wax, squalene, triglycerides and free fatty acids. In acne patients, sebum exhibits not only quantitative increases but also qualitative alterations, with elevated proportions of pro-inflammatory lipids such as free fatty acids and reduced levels of linoleic acid. The sebaceous gland's density is highest in seborrheic areas—the face, chest, and upper back—explaining the predilection of acne for these anatomical sites.[50]

Cutibacterium acnes Colonization

Cutibacterium acnes, an anaerobic, lipophilic commensal bacterium, proliferates in the lipid-rich, anaerobic microenvironment of the obstructed follicle. The organism metabolizes triglycerides into free fatty acids through its lipase activity, contributing to follicular inflammation. It also activates receptors like Toll-like receptors (TLR-2) on keratinocytes and monocytes, initiating pro-inflammatory cytokine cascades including interleukin (IL)-1α, IL-8, IL-12, and tumor necrosis factor-alpha (TNF-α). Additionally, C. acnes produces biofilms that enhance adherence to the follicular epithelium and contribute to antibiotic resistance.[51]

Inflammatory Response

The inflammatory phase of acne represents the culmination of several processes: (1) innate immune response to C. acnes, (2) production of pro-inflammatory cytokines and chemokines, (3) neutrophil recruitment, and (4) adaptive immune activation. The rupture of comedones into the dermis releases follicular contents, including keratin, sebum, and bacterial antigens, triggering a robust foreign-body inflammatory reaction. This often results in the formation of inflammatory papules, pustules, nodules, or cysts, depending on the depth and intensity of inflammation.[49,52]

Recent research has challenged the classical sequence of acne pathogenesis, suggesting that subclinical inflammation may precede follicular hyperkeratinization. Jeremny et.al., studied normal skin of acne patients and found increased pro-inflammatory cytokine interleukin-1 in perifollicular region.[53] These findings indicate that inflammation might be the initiating event rather than a secondary phenomenon.

Hormonal Influences

Androgens modulate dermal physiology through intracrine and paracrine mechanisms. Their role in acne pathogenesis is mediated by (1) stimulation of sebaceous gland growth and differentiation, (2) increased sebum production, (3) alterations in sebum composition, and (4) promotion of follicular keratinocyte proliferation.[15] In males, testosterone is the primary circulating androgen, with a significant portion converted to the more potent dihydrotestosterone (DHT) within the pilosebaceous unit through the action of 5α-reductase.

In females, androgens derive primarily from the ovaries and adrenal glands, with additional local production within sebaceous glands themselves.[54]

The relationship between acne and hyperandrogenism is evidenced by its increased prevalence in endocrinological conditions like PCOS and congenital adrenal hyperplasia (CAH).[55] However, most acne patients exhibit normal serum androgen levels, suggesting increased local androgen sensitivity or metabolism as contributing factors.

Metabolic Factors in Acne Pathogenesis

Recent evidence shows that metabolic factors play a crucial role in acne vulgaris pathophysiology, establishing important connections between BMI status and acne development. Several key pathways have been elucidated:

Insulin/IGF-1 Signalling Pathway

Hyperinsulinemia and elevated insulin-like growth factor-1 (IGF-1) significantly contribute to acne pathogenesis through multiple mechanisms. These include direct stimulation of sebaceous gland lipogenesis, enhancement of androgen synthesis, reduction in sex hormone-binding globulin (SHBG) production leading to increased free androgen levels, and promotion of follicular keratinocyte proliferation.[56] Notably, IGF-1 receptor expression is upregulated in acne-involved skin, suggesting heightened sensitivity to IGF-1 signaling in affected individuals as observed by Kim et.al., in cultured sebocytes.[57] Study by Cappel *et al*., has demonstrated positive correlations between IGF-1 levels in serum and the severity of acne, particularly in females, highlighting the potential diagnostic and therapeutic relevance of this pathway.[58]

mTORC1 Signaling

The mammalian target of rapamycin complex 1 (mTORC1) represents a central integrative pathway translating nutrient signals—particularly those from dairy products and high glycemic load foods—into cellular growth and metabolic responses. Melnik and Zouboulis proposed that excessive mTORC1 activation leads to increased sebaceous lipogenesis and altered sebum composition, contributing to follicular hyperkeratinization and microcomedone formation, they linked this with western diet which is rich in high glycaemic index foods.[59] This pathway provides a link between dietary factors and acne pathogenesis,

potentially explaining the observed associations between Western dietary patterns and acne prevalence. Interestingly, mTORC1 activity is modulated by BMI status, potentially mediating differential acne risk across BMI categories.[60]

Adipokines and Inflammatory Mediators

Adipose tissue functions as an active endocrine organ, secreting numerous bioactive molecules collectively termed adipokines. These include leptin, adiponectin, and cytokines such as TNF-α and IL-6.[61] Research by Kirichenko *et al* has demonstrated that adipokine profiles vary significantly with BMI status and directly modulate sebaceous gland function, lipogenesis, and inflammatory responses in pilosebaceous units.[62] Importantly, Haggag *et al*. observed mean adiponectin level was significantly higher in patients than controls, independent of total BMI, suggesting that qualitative aspects of adipose tissue function may be more relevant than quantitative measures in acne pathogenesis.[63]

These metabolic pathways provide crucial insights into the complex relationship between BMI and acne vulgaris observed across diverse populations. The integration of these mechanisms offers a comprehensive framework for understanding how anthropometric parameters may influence acne development and progression through direct and indirect effects on sebaceous gland function, inflammation, and keratinocyte.

Dietary Influences

The relationship between diet and acne, once dismissed, has gained substantial scientific support:

1. **High Glycemic Load Foods**: Foods with high glycemic indices and loads induce rapid increases in blood glucose, leading to hyperinsulinemia and elevated IGF-1 levels. Multiple randomized controlled trials have demonstrated that low glycemic load diets significantly reduce acne severity compared to high glycemic load diets.[64]
2. **Dairy Products**: Observational studies have found associations between dairy consumption, particularly skim milk, and acne.[65] Proposed mechanisms include:
    - Presence of hormones and growth factors in milk
    - Milk's insulinotropic properties
    - Stimulation of IGF-1 production
    - Activation of mTORC1 signaling by milk-derived amino acids

3. **Omega-6/Omega-3 Ratio**: Western diet has a high ratio, which may promote inflammation. Some evidence suggests that supplementation with omega-3 fatty acids may reduce inflammatory acne lesions. Khayef *et al* demonstrated an improvement in overall acne severity, with 3 grams of fish oil containing 930 mg of EPA given as supplementation especially for individuals with moderate to severe acne.[66]

Classification Systems for Acne Severity

Accurate assessment of acne severity is essential for research standardization, treatment selection, and monitoring therapeutic responses. Despite extensive research, there remains no universally accepted gold standard for acne grading, complicating cross-study comparisons.[67]

Global Acne Grading System (GAGS)

The GAGS evaluates six anatomical regions of face and trunk, with weighted importance. The number of lesions in each area is counted and multiplied by the area factor, and the sum determines overall severity:

- 1-18 = mild acne
- 19-30 = moderate acne
- 31-38 = severe acne
- 39 = very severe acne

Comprehensive Acne Severity Scale (CASS)[68]

The CASS evaluates acne on a 0-5 scale in five facial regions (forehead, each cheek, nose, and chin) and the chest/upper back:

- 0 = clear (no lesions)
- 1 = almost clear (few scattered comedones)
- 2 = mild (several papules/pustules, no nodules)
- 3 = moderate (many papules/pustules, few nodules)
- 4 = severe (numerous papules/pustules, many nodules)
- 5 = very severe (highly inflammatory acne covering the affected area)

Investigator's Global Assessment (IGA)[69]

The IGA uses a 5-point scale:

- 0 = clear
- 1 = almost clear (few non-inflammatory lesions)
- 2 = mild (some non-inflammatory and few inflammatory lesions)
- 3 = moderate (many non-inflammatory and inflammatory lesions)
- 4 = severe (numerous lesions of both types, nodules present)

Pillsbury Classification[70]

This system classifies acne into four grades:

- Grade I: comedones and occasional small cysts
- Grade II: comedones, papules, and few pustules
- Grade III: numerous papules, pustules, and occasional larger inflamed nodules
- Grade IV: cystic acne with many large inflammatory nodules and pustules

Leeds Revised Acne Grading System[71]

This system utilizes standardized photographs for grading acne separately on the face, back, and chest, with grades from 1 (least severe) to 10 (most severe).

In a study comparing the GAGA and IGA done by Alsulaimani *et al* the two methods for acne severity assessment were found reliable, and they exhibited strong consistency between raters.[72]

The severity of acne vulgaris was divided into four different categories by Indian authors using an elementary grading approach that considered the major lesion.[73]

- Grade 1: Predominantly comedones with papules.
- Grade 2: Papules, comedones and few pustules.
- Grade 3: Predominant pustules, nodules, abscesses.
- Grade 4: Cysts, abscesses, widespread scarring.

Table 1: Other grading systems for Acne

System Name	Assessment Approach	Anatomical Focus	Special Requirements
Frank Scale	Numerical assessment (0-4 or 0-10) based on individual lesion intensity	Facial and truncal regions	Not applicable
Plewig-Kligman Method	Distinct evaluation of non-inflammatory and inflammatory manifestations by quantity and morphology	Right facial hemisphere only (excludes contralateral side and trunk)	Not applicable
Christiansen Protocol[74]	Six-tier classification system (+4 to -1)	Region with highest lesion density	5 cm diameter circular template for standardized counting
Samuelson Technique[75]	Joint patient-physician evaluation using reference image comparison on 9-point scale	Complete facial and truncal assessment	Photographic documentation required
Lucchina Methodology[76]	Four-level classification system for comedonal assessment using specialized imaging	Facial region only	Fluorescent photography essential
Phillips Approach[77]	Specialized imaging technique for inflammatory lesion evaluation	Unspecified	Polarized light imaging system
Allen-Smith System	Combined photometric measurement with quantitative and qualitative assessment	Facial focus (trunk excluded)	Photographic documentation required

BMI as a Measure of Adiposity

Body Mass Index (BMI) serves as a screening tool for categorizing weight status based on the ratio of weight to height squared (kg/m^2). Though widely used for its simplicity and accessibility, BMI has significant limitations as a measure of adiposity.[78,79]

Advantages of BMI

1. **Simplicity and Accessibility**: BMI requires only height and weight measurements, making it feasible for large-scale epidemiological studies and clinical practice in resource-limited settings.
2. **Population-Level Correlations**: At the population level, BMI correlates with body fat percentage and health risks, making it valuable for public health surveillance and policy development.[80]
3. **Standardization**: BMI provides a standardized approach to weight classification, allowing for comparisons across populations and studies.
4. **Predictive Value**: Despite limitations, BMI demonstrates meaningful associations with various health outcomes, including metabolic disorders, cardiovascular disease, and mortality.[81,82]

Limitations of BMI

1. **Body Composition Indiscrimination**: cannot differnetiate between fat mass and lean mass (muscle, bone), which may lead to misclassifying muscular individuals as overweight or obese.[83,84]
2. **Fat Distribution Oversight**: BMI fails to account for fat distribution patterns, particularly visceral adiposity, which has greater metabolic significance than subcutaneous fat.[85,86]
3. **Ethnic Variations**: BMI-body fat relationships vary significantly across ethnic groups. As noted by Wang et al and Wulan et al, Asian populations typically have higher body fat percentages at equivalent BMI values compared to Caucasians.[87,88]
4. **Age and Sex Considerations**: The relationship between BMI and adiposity changes across the lifespan and differs between males and females, limiting interpretation without considering these factors.[89,90]
5. **Special Populations**: BMI may be inaccurate measure of metabolic dysfunction in athletes, pregnant women, the elderly, and children, where body composition and proportions differ from standard adult patterns.[91,92]

Alternative Adiposity Measures

Several alternative measures address some limitations of BMI:

1. **Waist Circumference (WC)**: Provides information about central adiposity, correlating with visceral fat and metabolic risk. As discussed by Lofgren et al, WC may be a better predictor of cardiometabolic risk than BMI alone.[93,94]
2. **Waist-to-Hip Ratio (WHR)**: Reflects body fat distribution by comparing waist and hip circumferences, with higher ratios indicating greater central adiposity.
3. **Waist-to-Height Ratio (WHtR)**: Accounts for height differences in assessment of central adiposity, with cutff of >0.5 generally indicating increased health risk.[95]
4. **Body Fat Percentage**: Adiposity (body fat) can be measured directly using methods like bioelectrical impedance analysis (BIA), dual-energy X-ray absorptiometry (DEXA), or skinfold thickness measurement.[96]
5. **Visceral Adiposity Index (VAI)**: Estimates visceral adiposity function using anthropometric (BMI, WC) and metabolic parameters (triglycerides, HDL cholesterol).[97]

Despite these alternatives, BMI remains widely used due to its practicality and established epidemiological significance, particularly when applied with appropriate ethnic-specific thresholds.

WHO and Asian-Pacific BMI Classification Systems:

The classification of overweight and obesity based on BMI has evolved to recognize ethnic variations in body composition and associated health risks, resulting in the development of population-specific thresholds.

WHO International Classification

The World Health Organization established standardized BMI categories in 1995, with updates in 2000 and 2004, creating the following widely used classification:[10]

- Underweight: <18.5 kg/m²

- Normal weight: 18.5-24.9 kg/m²
- Overweight: 25.0-29.9 kg/m²
- Obesity class I: 30.0-34.9 kg/m²
- Obesity class II: 35.0-39.9 kg/m²
- Obesity class III: ≥40.0 kg/m²

These thresholds were primarily derived from data in European and North American populations and correlate with morbidity and mortality risks in these groups.

Asian-Pacific Classification

Recognizing that Asian populations exhibit elevated metabolic risk at lower BMI values than Caucasians, the WHO Western Pacific Regional Office and the International Association for the Study of Obesity proposed revised BMI cutoffs for Asian populations:[98,99]

- Underweight: <18.5 kg/m²
- Normal weight: 18.5-22.9 kg/m²
- Overweight: 23.0-24.9 kg/m²
- Obesity class I: 25.0-29.9 kg/m²
- Obesity class II: ≥30.0 kg/m²

This classification, sometimes referred to as the "Asian criteria" or "Asian-Pacific criteria," acknowledges that Asian populations typically have higher body fat percentages at equivalent BMI values compared to Caucasians.

Indian-Specific Considerations[11,12]

The updated definition of obesity for Asian Indians living in India, as proposed by Misra et al. (2024), recommends the following BMI grades:

- Normal: 18.5-22.99 kg/m²
- Grade I: 23-24.9 kg/m²
- Grade II: 25-27.5 kg/m²
- Grade III: 27.6-32.4 kg/m²
- Grade IV: ≥32.5 kg/m²

Furthermore, Misra et al. propose a staging system that incorporates not only BMI but also functional limitations and comorbidities, distinguishing between:

- Stage 1 Obesity: Evidence of adiposity (BMI >23 kg/m²) with no impact on organ functions or daily activities.
- Stage 2 Obesity: Increased adiposity affecting physical and organ functions, causing functional limitations, and contributing to comorbid diseases

Comparative Significance

The choice of BMI classification system has substantial implications for research, clinical practice, and public health:

1. **Prevalence Estimates**: Using Asian-specific rather than WHO international cutoffs significantly increases the estimated prevalence of overweight and obesity in Asian populations.[100–102]
2. **Risk Stratification**: Asian-specific thresholds improve identification of individuals at elevated cardiometabolic risk who would be classified as "normal weight" by conventional WHO criteria.[103,104]
3. **Intervention Thresholds**: Lower BMI thresholds for Asians suggest earlier intervention for weight management in this population.
4. **Research Interpretation**: Studies using different BMI classification systems may reach divergent conclusions, complicating literature interpretation.[105]

The choice between WHO and Asian-specific BMI classifications in research on BMI-acne relationships is particularly significant, as it may influence the detected strength and pattern of associations.

Previous Studies on the Relationship Between BMI/Obesity and Acne

The relationship between BMI/obesity and acne has been investigated across diverse populations with inconsistent findings. This section synthesizes the current evidence base, highlighting both supportive and contradictory findings.

Evidence Supporting a Positive Association

Several studies have found significant positive associations between elevated BMI and acne:

1. Tsai et al conducted a study in Taiwan involving 3,274 schoolchildren and found a significant association between higher BMI and acne development. They observed that children with a BMI below 18.5 had a lower prevalence of inflammatory acne lesions. [106]
2. Lu et al studied 659 Chinese adolescents and young adults and found that individuals with moderate to severe acne had significantly higher average BMI than the control group. The odds of developing moderate-to-severe acne were 5.027 times higher in overweight or obese individuals compared to those with a normal or underweight BMI.
3. Di Landro *et al* conducted a case-control study in Italy involving 563 participants aged 10-24 years, demonstrating that individuals with a BMI above 18.5 kg/m² had increased odds of moderate-to-severe acne compared to those with BMI <18.5 kg/m².[107]
4. Karciauskiene *et al*. found in a Lithuanian population that high BMI (≥25 kg/m²) was significantly associated with acne, with an odds ratio of 2.6 after adjusting for age and sex.[107]
5. Al-Kubaisy *et al.* observed among Syrian university students that acne prevalence significantly increased with increasing BMI categories, from 18.5% in underweight students to 60% in those with BMI ≥30 kg/m².[108]

Evidence Suggesting No Association or Inverse Relationship

Contradicting these positive findings, several studies have found no significant association or even inverse relationships:

1. Halvorsen *et al* conducted a large population-based study among 3,655 Norwegian adolescents and found no significant association between BMI and acne prevalence or severity after adjusting for confounding factors.[109]

2. Alowairdhi *et al* found in a Saudi Arabian tertiary hospital-based study found a potential inverse relationship.[110]
3. Neupane *et al* found no significant relationship between BMI and acne severity across all acne grades in a Nepalese population.[111]
4. Snast *et al* reported an inverse association between overweight/obesity and acne in a study of Israeli adolescents, with acne prevalence gradually decreasing from underweight to severely obese categories.[112]
5. Lu and Hsu found a negative relationship between BMI and the number of acne lesions, particularly in Taiwanese women with post-adolescent acne, indicating possible gender-specific effects.

Several factors may explain the inconsistent relationship between BMI and acne across studies:

1. **Population Heterogeneity**: Genetic, dietary, and environmental differences across study populations may modify the BMI-acne relationship.
2. **Age Differences**: The relationship between BMI and acne may vary between adolescent and adult populations due to differences in hormonal milieu and acne pathophysiology.[113]
3. **Gender-Specific Effects**: Several studies suggest different BMI-acne relationships in males versus females, potentially due to sex-specific hormonal influences.[114]
4. **BMI Classification Systems**: Studies using different BMI cutoffs (WHO versus Asian-specific) may reach different conclusions, particularly in Asian populations.
5. **Acne Classification Heterogeneity**: Variation in acne grading systems across studies complicates cross-study comparisons.
6. **Confounding Factors**: Inconsistent adjustment for confounders such as diet, stress, and hormonal factors may influence findings.
7. **Study Design Limitations**: Retrospective designs, selection bias, and small sample sizes in some studies limit conclusive interpretations.

This complex and contradictory evidence base underscores the importance of well-designed studies in diverse populations using standardized assessment methods to clarify the true nature of the BMI-acne relationship.

Metabolic Factors Linking Adiposity and Acne

The biological mechanisms potentially linking adiposity and acne involve complex interplays between endocrine, metabolic, and inflammatory pathways. Understanding these mechanisms provides the theoretical foundation for investigating BMI-acne associations. Insulin Resistance and Hyperinsulinemia.[115,116]

Excess adiposity, particularly visceral fat, contributes to insulin resistance through several mechanisms:

1. **Free Fatty Acid Effects**: Enlarged adipocytes release increased free fatty acids that impair insulin signaling in liver and muscle tissue.[117]
2. **Adipokine Dysregulation**: Obesity alters the production of adipokines (adiponectin, leptin, resistin) that modulate insulin sensitivity.[118]
3. **Ectopic Fat Deposition**: Lipid accumulation in liver and muscle contributes to local insulin resistance.

The resulting hyperinsulinemia may promote acne through multiple pathways:

1. **Enhanced Androgen Production**: Insulin stimulates androgen production while reducing hepatic synthesis of SHBG, resulting in higher free androgen levels.[119,120]
2. **Direct Sebocyte Effects**: Insulin receptors expressed on sebaceous glands respond to hyperinsulinemia with increased sebum production and altered sebum composition.[57]
3. **Keratinocyte Proliferation**: Insulin promotes follicular keratinocyte proliferation, contributing to follicular hyperkeratosis and microcomedone formation.[58]

IGF-1 Signaling Pathway

IGF-1 represents a critical mediator in the adiposity-acne relationship:

1. **Obesity-IGF-1 Relationship**: Obesity generally associates with elevated IGF-1 levels, though this relationship is complex and may vary with age, gender, and ethnicity.[121,122]
2. **IGF-1 Effects on Sebaceous Glands**:[123,124]
    - Stimulates sebocyte proliferation and differentiation
    - Increases sebaceous lipogenesis

    - Upregulates sterol response element-binding proteins (SREBPs) that regulate lipid synthesis
    - Amplifies androgen receptor signaling in sebocytes
3. **Keratinocyte Effects**: IGF-1 promotes follicular keratinocyte growth and inhibits apoptosis, contributing to follicular hyperkeratinization.[125]

Seleit et al. in 2014 demonstrated in a case-control study that BMI positively correlated with in situ expression of IGF-1 in skin biopsies from acne patients using standard immunohistochemical techniques, providing direct evidence linking adiposity, IGF-1, and acne pathogenesis.[126]

Androgen Metabolism Alterations

Adipose tissue significantly influences androgen metabolism, potentially affecting acne pathogenesis:

1. **Aromatization**: Adipose tissue expresses aromatase, which converts androgens to estrogens. This effect might be expected to reduce acne by decreasing androgen levels, potentially explaining inconsistent BMI-acne associations.[127]
2. **11β-Hydroxysteroid Dehydrogenase Type 1 (11β-HSD1)**: Adipose tissue expresses 11β-HSD1, which activates cortisone to cortisol. This enzyme also metabolizes androgen precursors, potentially affecting local androgen levels in the skin.[128]
3. **5α-Reductase Activity**: Some studies suggest obesity may affect 5α-reductase activity, which converts testosterone to dihydrotestosterone (DHT). Alan et al. found that higher BMI in women was associated with hyperandrogenism and more severe acne, while other studies suggest obesity might decrease 5α-reductase-II activity.[129]

Inflammation and Cytokine Dysregulation

Adipose tissue functions as an active endocrine organ, and obesity creates a state of chronic low-grade inflammation that may influence acne:

1. **Pro-inflammatory Cytokine Production**: Excess adipose tissue, particularly visceral fat, secretes cytokines (TNF-α, IL-6, IL-1β) that may exacerbate the inflammatory component of acne.[130,131]
2. **Adipokine Dysregulation**: Obesity alters the production of adipokines like leptin (increased) and adiponectin (decreased), affecting inflammatory responses and possibly sebaceous gland function.[132]
3. **Oxidative Stress**: Obesity increases systemic oxidative stress, which may contribute to inflammation and altered sebum composition in acne.[133,134]

Dietary Patterns and mTORC1 Signaling

Obesity is often associated with specific dietary patterns that independently influence acne through mTORC1 (mammalian target of rapamycin complex 1) signaling:[59]

1. **High Glycemic Load**: Diets high in refined carbohydrates induce hyperinsulinemia and IGF-1 elevation, activating the mTORC1 pathway.[135,136]
2. **Dairy Consumption**: Dairy products contain growth factors and branched-chain amino acids that activate mTORC1 signaling, potentially exacerbating acne.[137,138]
3. **Western Diet Pattern**: The typical Western diet pattern, characterized by high glycemic load, dairy, and saturated fats, activates mTORC1 and promotes inflammation, potentially contributing to both obesity and acne.[139]

These interconnected metabolic pathways provide biological plausibility for BMI-acne associations, though their relative importance likely varies across individuals and populations due to genetic, environmental, and lifestyle factors.

Studies on Acne in Adult Population

Adult acne represents a significant clinical entity with distinct epidemiological, clinical, and psychological characteristics compared to adolescent acne. This section synthesizes current knowledge about acne in adult populations.[6,7]
Epidemiology and Classification

Adult acne can be classified as:

1. **Persistent Acne**: Continues from adolescence into adulthood, representing approximately 80% of adult acne cases.
2. **Late-Onset Acne**: seen after age 25, comprising approximately 20% of adult acne cases.

Epidemiological studies reveal substantial prevalence:

- Collier et al. found that 12-14% of women and 3-5% of men over age 25 have clinical acne.[7]
- Shen et al. reported in a large Chinese study (n=17,345) that adult acne accounts for 25% of the total acne population, with persistent acne being much more common than late-onset acne.[140]
- Di Landro et al. found in an Italian case-control study that 50% of women experiencing acne after age 25 had no previous adolescent acne history.[141]

Clinical Characteristics

Adult acne presents with distinct clinical features compared to adolescent acne:

1. **Lesion Type and Distribution**:
    - Predominantly inflammatory papules and nodules with fewer comedones
    - Primarily affects the lower face, jawline, and chin in a "U-zone" distribution
    - Less likely to affect the forehead and cheeks ("T-zone") compared to adolescent acne
2. **Gender Predilection**:
    - Strong female predominance (female ratio approximately 5:1).[46]
    - In males, persistent acne is more common than late-onset acne.
3. **Course and Severity**:
    - Generally less severe but more persistent than adolescent acne
    - Often treatment-resistant
    - Frequent premenstrual flares in women (reported by 40-78% of female patients)[142]

Shen et al. (2012) observed that late-onset acne had a lower severity grade and fewer premenstrual flare-ups compared to persistent acne, suggesting possible differences in underlying pathophysiological mechanisms.[140]

Table 2: Clinical variants of acne[143–145]

S.No	Types	Salient Features
1	**Drug-induced acne**	Corticosteroids, ACTH, anticonvulsants, antidepressants, antitubercular, antiviral, calcium antagonists, vitamins, and antipsychotic drugs induce acne.
2	**Cosmetic acne**[146]	Cosmetic products containing comedogenic ingredients such as lanolin, petrolatum, vegetable oils and oleic acid can contribute to acne.
4	**Occupational acne**	Due to exposure to polyhalogenated organic compounds containing naphthalene, biphenyls, and phenols.
5	**Severe forms**	-
	a) **Acne fulminans**	Tender inflammatory nodules with hemorrhagic crusts and ulceration. Commonly distributed on the back, upper chest, and shoulders. More common in males aged 13-22 years.
	b) **Acne conglobata**	Multiple comedones and inflammatory papules, pustules, tender nodules, abscesses, and draining sinus tracts. Common in males aged 20-30 years.
6	**Acne associated with psychosis problems**	-
	a) **Acne excoriée**	Commonly seen in adolescent girls who pick real or imaginary acne, mostly on the face.
	b) **Body dysmorphic disorder**	Patients are often depressed or have obsessive-compulsive disorder.
	c) **Eating disorder**	Anorexia nervosa.
7	**Granulomatous acne**	Deep, well-demarcated lesions commonly on the cheeks.
8	**Acne mechanica**	Due to repeated mechanical trauma and friction. Examples include fiddler's neck in violin players, headbands, and collars.

Pathophysiological Considerations

Adult acne involves several pathophysiological mechanisms that may differ from adolescent acne:

1. **Hormonal Factors**:
    - Subtle hyperandrogenism in many women with adult acne
    - Increased sensitivity to normal androgen levels
    - Hormonal fluctuations related to menstrual cycle, pregnancy, and perimenopause[147]
    - Disorders such as PCOS may underlie some cases of adult female acne
2. **Follicular Hyperkeratinization**:
    - May be more prominent in adult acne
    - Often associated with external factors such as cosmetics and occupational exposures[148]
3. **Inflammation**:
    - Possibly more significant with deeper inflammatory processes
    - May be influenced by stress, which is commonly reported by adult acne patients[149]
4. **Barrier Dysfunction**:
    - Some evidence suggests impaired skin barrier function in adult acne
    - May contribute to increased sensitivity to topical agents

Aggravating Factors

Several factors may specifically trigger or worsen adult acne:

1. **Stress**: Consistently reported as a major exacerbating factor in adult acne. Al-Kubaisy et al. found that individuals who were continuously subjected to stress demonstrated significantly more rates of acne.[108]
2. **Cosmetics**: Occlusive cosmetics and skincare products contribute to "acne cosmetica," a common issue in adult women.[146]

3. **Medications**: Various medications including corticosteroids, anticonvulsants, lithium, vitamins B6/B12, and anabolic steroids may induce or worsen adult acne.[150]
4. **Endocrine Disorders**: Conditions such as PCOS, congenital adrenal hyperplasia, and Cushing's syndrome may underlie persistent hormonal acne.[151]
5. **Dietary Factors**: High glycemic load diets and dairy consumption may exacerbate adult acne similarly to adolescent acne.[65]
6. **Smoking**: Some studies suggest smoking may worsen acne, particularly non-inflammatory lesions, in adults.[152]

Psychological Impact

Adult acne carries significant psychological burdens, often exceeding those of adolescent acne:

1. **Psychological Distress**: Adults with acne report higher levels of anxiety, depression, and social withdrawal compared to unaffected peers.
2. **Professional Impact**: Adult acne can negatively affect workplace confidence and perceived professional competence.
3. **Quality of Life**: Multiple studies demonstrate significant impairment in quality of life measures, particularly in women with facial acne.
4. **Unrealistic Expectations**: Adults often expect to have "outgrown" acne, making its persistence or new onset particularly distressing.

These psychological aspects underscore the importance of effective management strategies for adult acne.

Treatment Considerations

Management of adult acne requires consideration of its unique features:

1. **Enhanced Skin Sensitivity**: Adults often experience greater irritation from traditional acne therapies, necessitating gentler approaches.
2. **Hormonal Therapy**: Hormonal interventions (e.g., combined oral contraceptives, spironolactone) play a larger role in adult female acne than in adolescent acne.

3. **Addressing Comorbidities**: Management of associated conditions such as PCOS, insulin resistance, or hirsutism may improve acne outcomes.
4. **Maintenance Therapy**: The chronic nature of adult acne often necessitates long-term maintenance strategies.
5. **Cosmetic Camouflage**: Techniques to minimize acne visibility may be particularly important for working adults.

The distinctive features of adult acne highlight the need for studies specifically investigating factors, including BMI, that may influence its development and severity in adult populations.

Research Gaps in Indian/South Asian Context

Despite the global burden of acne vulgaris and its significant impact on South Asian populations, substantial knowledge gaps persist in understanding acne epidemiology, pathophysiology, and risk factors in this region.

Limited Epidemiological Data

South Asian populations, particularly Indian populations, remain underrepresented in acne epidemiology research:

1. **Prevalence Studies**: Few large-scale, community-based studies have examined acne prevalence across different regions of India, with most existing studies limited to specific age groups, clinical settings, or geographic areas.
2. **Adult Acne**: Data on adult acne prevalence, particularly in Indian populations, are scarce. The clinical and demographic characteristics of adult acne in South Asian populations remain poorly characterized.
3. **Regional Variations**: India's considerable geographic, genetic, dietary, and cultural diversity suggests potential regional variations in acne epidemiology that remain largely unexplored.
4. **Longitudinal Data**: No substantial longitudinal studies track acne prevalence, severity, and risk factors over time in South Asian populations, limiting understanding of temporal trends and natural history.

BMI-Acne Relationship

The relationship between BMI and acne in South Asian populations requires further investigation:

1. **Contradictory Findings**: Studies examining BMI-acne relationships in South Asian populations have yielded inconsistent results, with some suggesting positive associations and others finding no significant relationship.
2. **Asian-Specific BMI Classifications**: Few studies have applied Asian-specific BMI classifications when investigating acne relationships, despite evidence that conventional WHO classifications may misclassify adiposity-related risk in South Asian populations.
3. **Body Composition**: Research examining the relationship between body composition (rather than simple BMI) and acne is almost nonexistent in South Asian populations, despite evidence suggesting that South Asians have higher body fat percentages at equivalent BMI values compared to Caucasians.
4. **Metabolic Parameters**: Limited research has examined whether specific metabolic parameters (insulin resistance, IGF-1, lipid profiles) mediate potential BMI-acne relationships in South Asian populations.

Pathophysiological Considerations

Several pathophysiological aspects of acne in South Asian populations remain poorly understood:

1. **Genetic Factors**: While familial clustering suggests genetic contributions to acne in South Asian populations, specific genetic determinants remain largely uncharacterized.
2. **Skin Microbiome**: The cutaneous microbiome and its relationship to acne has been minimally studied in South Asian populations, despite potential influences of climate, hygiene practices, and dietary patterns on microbial communities.
3. **Sebum Composition**: Limited research has examined sebum composition and production in South Asian individuals with acne, despite potential ethnic variations in sebaceous gland activity and lipid profiles.
4. **Hormonal Patterns**: The relationship between hormonal profiles (androgens, insulin, IGF-1) and acne in South Asian populations requires further investigation,

particularly given the high prevalence of insulin resistance and PCOS in this population.

Clinical and Therapeutic Gaps

Clinical and therapeutic research also demonstrates substantial gaps:

1. **Treatment Response**: Limited data exist regarding treatment response patterns in South Asian acne patients, despite potential influences of genetic, environmental, and cultural factors on therapeutic outcomes.
2. **Post-Inflammatory Hyperpigmentation**: Although post-inflammatory hyperpigmentation represents a significant concern in darker-skinned populations, including South Asians, research addressing its prevention and management in South Asian acne patients remains limited.
3. **Cultural Practices**: The impact of culturally specific skincare practices, cosmetic use, and traditional medicines on acne
4. **Dietary Factors**: Although the relationship between diet and acne has gained scientific credibility, South Asian dietary patterns—characterized by regional variations in staple grains, cooking methods, and spice use—have not been adequately studied in relation to acne.
5. **Environmental Influences**: The effects of climate, pollution, and occupational exposures on acne in South Asian settings require further investigation, particularly given rapid urbanization and environmental changes in the region.

Methodological Limitations

Research on acne in South Asian populations has been hampered by several methodological limitations:

1. **Inconsistent Grading Systems**: Studies have utilized various acne grading systems, complicating cross-study comparisons and meta-analyses.
2. **Selection Bias**: Many studies rely on clinic-based rather than community-based sampling, potentially overrepresenting severe cases and specific demographic groups.

3. **Confounding Variables**: Inconsistent adjustment for potential confounders such as diet, cosmetic use, family history, and stress limits interpretation of reported associations.
4. **Sample Size Limitations**: Many studies have insufficient statistical power to detect modest associations or to perform meaningful subgroup analyses.
5. **Cross-Sectional Designs**: The predominance of cross-sectional studies limits causal inference and understanding of temporal relationships between risk factors and acne development.

Specific Gaps in North Karnataka

Research gaps are particularly pronounced for the North Karnataka population:

1. **Limited Demographic Representation**: This region remains underrepresented in the acne literature, with few studies specifically focusing on its population.
2. **Changing Dietary Patterns**: The dietary transition occurring in North Karnataka, characterized by increasing consumption of processed foods alongside traditional foods, has not been adequately studied in relation to acne risk.
3. **Occupational Factors**: The relationship between occupational exposures common in North Karnataka (agricultural chemicals, industrial pollutants) and acne has not been investigated.
4. **Socioeconomic Disparities**: The impact of socioeconomic factors on acne prevalence, severity, and management in this region remains largely unexplored.
5. **Healthcare Access**: Barriers to dermatological care and their influence on acne-related outcomes in North Karnataka require further investigation.

Addressing these research gaps through well-designed studies in South Asian populations, particularly in underrepresented regions like North Karnataka, will enhance understanding of acne pathophysiology, improve clinical management, and potentially identify population-specific preventive strategies.

METHODOLOGY:

SOURCE OF DATA

Patients presented to Shri BM Patil Medical College Hospital and Research centre, Vijayapura.

Period of study: The study was done during the period of May 2023 to January 2025

Study design: A hospital-based, prospective cross-sectional study.

Sample Size:

- The anticipated Mean±SD of BMI in AV patients 24.2±26.1 and in controls 20.6±2.9 resp. [ref] the required sample size is 312 per group (i.e. a total samle size of 624, assuming equal group sizes) to get a power of 85% and a level of significance of 5% (two sided), for detecting a true difference in means between two groups.

$$N = 2\left[\frac{(Z_{\propto} + z_{\beta}) * S}{d}\right]^2$$

$Z_{\propto}$ Level of significance=95%

Z_{β}--power of the study=85%

d=clinically significant difference between two parameters

SD= Common standard deviation

Statistical Analysis

- The data obtained was be entered in a Microsoft Excel sheet, and statistical analysis will be performed using statistical package for the social sciences SPSS (Version 20).
- Results will be presented as Mean±SD, counts and percentages and diagrams.
- For normally distributed continuous variables between two groups was be compared using Independent t test For and not normally distributed variables Mann Whitney U

test will be used. Categorical variables between two groups will be compared using Chi square test.

- $p<0.05$ will be considered statistically significant. All statistical tests were performed in two-tailed.

METHOD OF COLLECTION OF DATA:

Patient suffering from acne vulgaris, irrespective of gender, aged above 18 years were enrolled in the study after obtaining consent.

Inclusion criteria:

- Adults aged 18 years and above
- Clinical diagnosis of acne vulgaris
- Willing to participate and provide informed consent

Exclusion criteria:

- The presence of a treatment history of acne in form of topical or systemic treatment within the last 1 month.
- Known endocrinological disorders
- Pregnancy or lactation
- Unwillingness to participate in the study

Controls

Controls were selected from adult patients attending the dermatology outpatient department for conditions other than acne vulgaris or attenders of the patient were included.

Methods:

An initial clinical examination was done, and clinical symptoms and signs with skin lesions were noted in a proforma

Acne severity was evaluated by Pilsbury grading to assign grades to acne vulgaris, which divides the condition into four categories based on the major lesion.

- Grade 1: Predominantly comedones and few papules
- Grade 2: Papules, comedones, few pustules
- Grade 3: Predominant pustules, nodules, abscesses
- Grade 4: Cysts, abscesses and scarring

Anthropometric measurements were conducted by following standardized protocols:

1. **Height**: Measured using a stadiometer with participants standing barefoot, heels together, and head positioned in the Frankfurt horizontal plane. Measurements were recorded to the nearest 0.01m.
2. **Weight**: Measured using a digital scale with participants wearing light clothing and no footwear. Measurements were recorded to the nearest 0.1 kg.
3. **Body Mass Index (BMI)**: Calculated as weight (kg) divided by height squared (m^2).

The statistical analysis plan was developed in consultation with a biostatistician to ensure appropriate methodology and interpretation of results.

BMI Classification Systems

BMI values were categorized according to both WHO international and Asian-specific classification systems to compare their utility in identifying associations with acne severity:

WHO International Classification:

- Underweight: <18.5 kg/m^2
- Normal weight: 18.5-24.9 kg/m^2

- Overweight: 25.0-29.9 kg/m²
- Obesity: ≥30.0

Asian-Specific Classification:

- Underweight: <18.5 kg/m²
- Normal weight: 18.5-22.9 kg/m²
- Overweight: 23.0-24.9 kg/m²
- Obesity: ≥25.0

Ethical Considerations

Institutional ethical commitee clearance was undertaken for the study

RESULTS

This hospital based cross-sectional study was conducted of May 2023 to January 2025. A total of 312 patients with acne vulgaris (>18 years) were included attending dermatology OPD at Shri BM Patil medical college during this period, along with 312 age and sex matched controls.

⇒ **Distribution of Age:**

Out of total 312 cases the mean of age was 23.08 ± 5.23 years, and for controls 25.03 ± 5.08 years. Majority cases were in the ≤22 age group ((60.26%) with Fewer cases in the older age groups.

Group	Count	Mean Age	Std Dev	Min	25th %	Median (50%)	75th %	Max
Cases	312	23.08	5.23	18	19.75	22.0	24.0	46
Controls	312	25.03	5.08	18	21.00	25.0	29.0	41

Table 3: Mean and Median of age in Cases and Controls

Age Group	Cases (n=312)	%	Controls (n=312)	%	Total (n=624)	%
≤ 22	188	60.3	123	39.4	311	49.8
23 - 27	71	22.8	90	28.8	161	25.8
28 - 32	31	9.9	76	24.4	107	17.1
≥ 33	22	7.1	23	7.4	45	7.2

Total	312	100	312	100	624	100

Table 4: Age Distribution in Cases and Controls

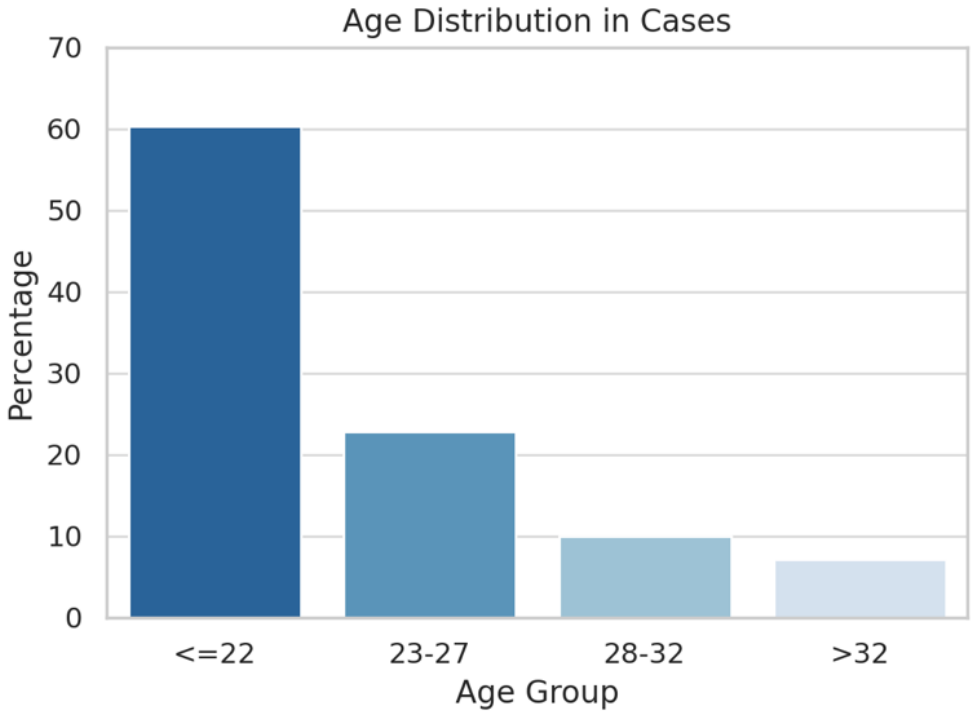

Figure 1: Age Distribution in Cases

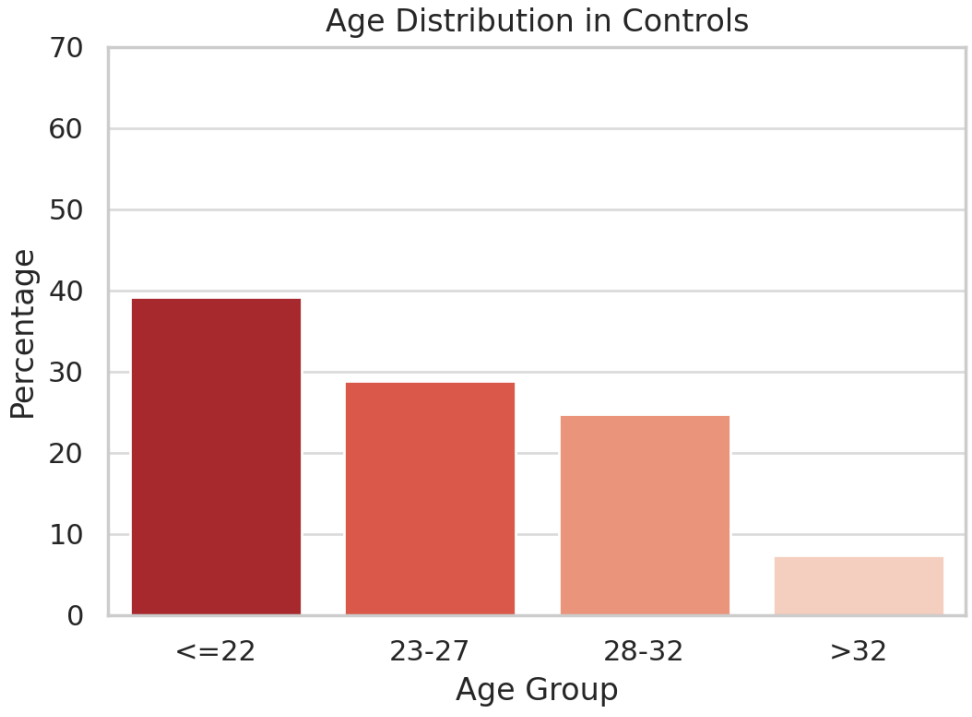

Figure 2: **Age Distribution in Controls**

⇒ **Distribution of gender:**

Females were more prevalent in both groups (**56.3% of total sample**). **Males** made up **43.8%** of the total sample, with slightly more in controls (44.9%) than cases (42.6%). **Female-to-Male Ratio in cases was 1.35:1**, meaning there are **1.35 females for every male** in the cases group.

Gender	**Cases (n=312)**	**%**	**Controls (n=312)**	**%**	**Total (n=624)**	**%**
Female	179	57.4	172	55.1	351	56.3
Male	133	42.6	140	44.9	273	43.8
Total	312	100	312	100	624	100

Table 5: Gender Distribution in Cases and Controls

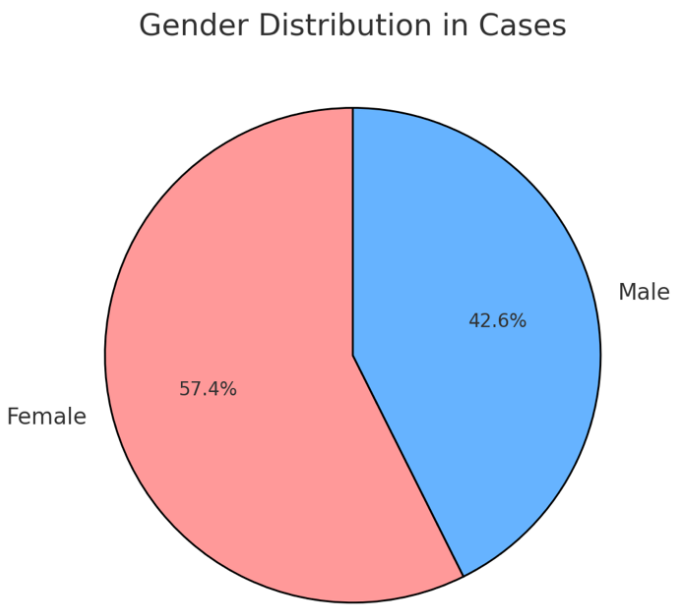

Figure 3: Gender Distribution in Cases

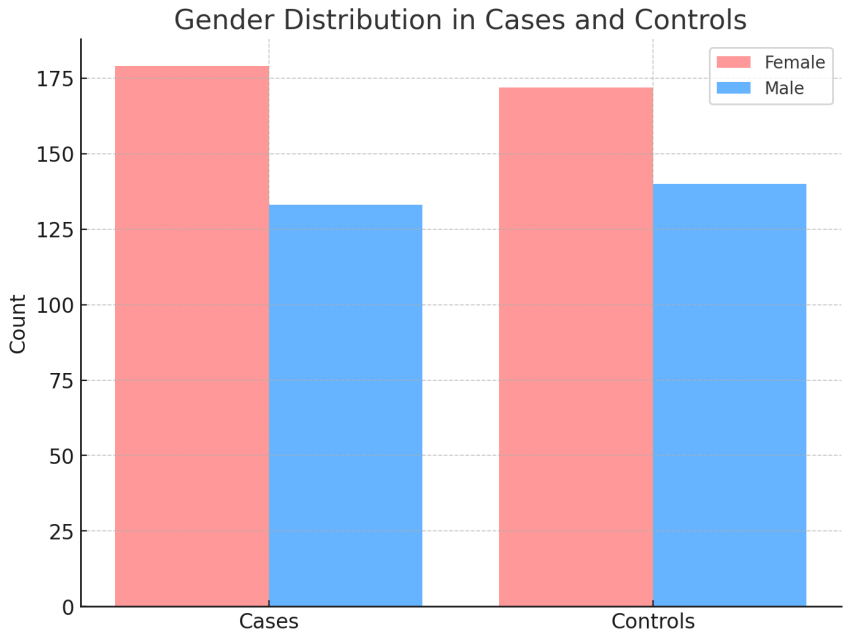

Figure 4: Grouped Bar Chart showing Gender Distribution in Cases and Controls

Demographic Analysis (cases + controls)

- Mean age: 24.1 ± 5.2 years

- Gender distribution: 56.3% Female

- Mean BMI: 22.0 ± 3.7 kg/m²

⇒ **Distribution of BMI among Cases and Controls**

Under the WHO classification, the majority of cases and controls were in **normal weight category (61.5% of cases and 61.2% of controls)**. A higher proportion of controls (23.7%) were overweight compared to cases (17.0%), while obesity was more frequent among cases (2.6%) than controls (1.0%).The chi-square test indicates a **statistically significant difference between cases and controls (χ^2=7.932, p=0.047)**.

In Asian classification, normal weight remains the most common category (49.7% of cases and 46.2% of controls), but the proportion of overweight and obese individuals is higher. More controls (24.7%) were classified as obese compared to cases (19.6%). However, the chi-square test did not show a significant association between BMI of cases and controls (χ^2=5.635, p=0.131).

WHO BMI Classification				
	GRPA		Total	
	Cases	Controls		

Cat	Underweight <18.5	Count	59	44	103	χ^2=7.932, **p=0.047**
		%	18.9%	14.1%	16.5%	
	Normal weight (18.5-24.9)	Count	192	191	383	
		%	61.5%	61.2%	61.4%	
	Overweight (25-29.9)	Count	53	74	127	
		%	17.0%	23.7%	20.4%	
	Obese >30	Count	8	3	11	
		%	2.6%	1.0%	1.8%	
Total		Count	312	312	624	
		%	100.0%	100.0%	100.0%	

Table 6: Distribution of BMI (WHO Classification) in Cases and Controls

Asian BMI Classification						
			GRPA		Total	
			Cases	Controls		
Cat	Underweight <18.5	Count	59	44	103	
		%	18.9%	14.1%	16.5%	
	Normal weight (18.5-22.9)	Count	155	144	299	
		%	49.7%	46.2%	47.9%	
	Overweight (23.0-24.9)	Count	37	47	84	χ^2=5.635, p=0.131
		%	11.9%	15.1%	13.5%	
	Obese >25	Count	61	77	138	
		%	19.6%	24.7%	22.1%	
Total		Count	312	312	624	
		%	100.0%	100.0%	100.0%	

Table 7: Distribution of BMI (Asian Classification) in Cases and Controls

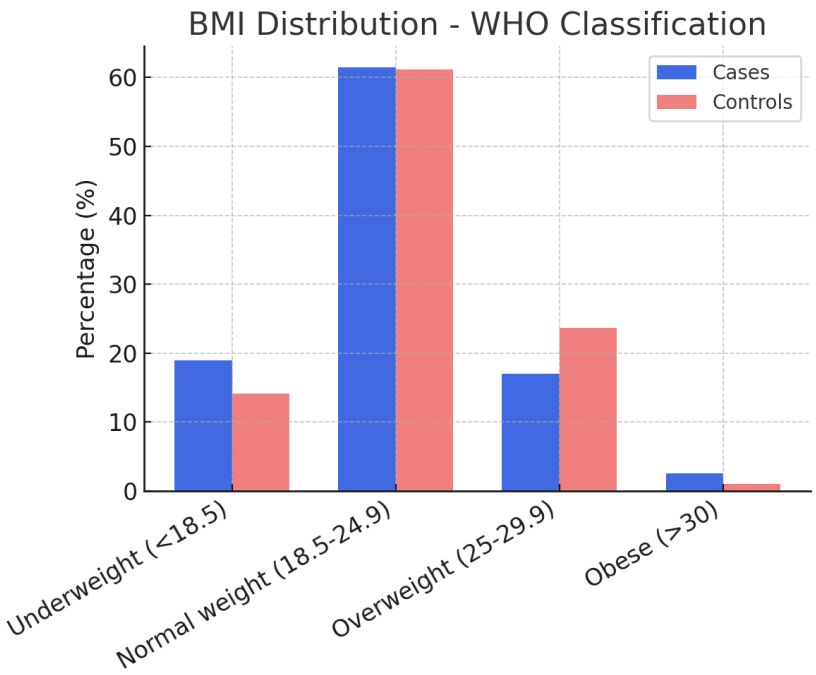

Figure 5: Distribution of BMI (WHO Classification) in Cases and Controls

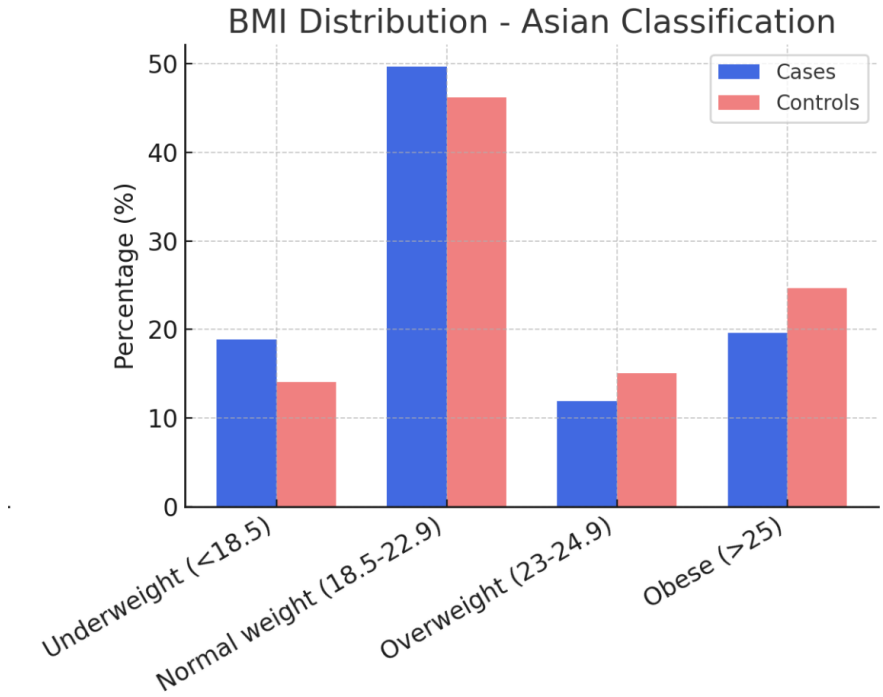

Figure 6: Distribution of BMI (Asian Classification) in Cases and Controls

⇒ **Distribution of Acne Cases (and Correlation of BMI with Acne grading)**

- Normal-weight individuals constitute the majority in all acne severity grades.
- Underweight individuals have the highest proportion in Grade 4 acne (38.5%)**.**
- Obese individuals are relatively less across all severity grade**s.**
- Grade 2 acne is the most frequent across all BMI categories.

Grading	Cases (n)	Percentage (%)
Grade 1	67	21.5%
Grade 2	201	64.4%
Grade 3	31	9.9%
Grade 4	13	4.2%
Total	**312**	**100.0%**

Table 8: Distribution of acne severity grades among case

Crosstab – BMI (WHO) and Acne grading								
			GRADING					
			GRADE 1	GRADE 2	GRADE 3	GRADE 4	Total	
Cat	Underweight <18.5	Count	17	30	7	5	59	χ^2=17.952, **p= 0.036**
		%	25.4%	14.9%	22.6%	38.5%	18.9%	
	Normal weight (18.5-24.9)	Count	32	134	19	7	192	
		%	47.8%	66.7%	61.3%	53.8%	61.5%	
	Overweight (25-29.9)	Count	14	34	5	0	53	
		%	20.9%	16.9%	16.1%	0.0%	17.0%	
	Obese >30	Count	4	3	0	1	8	
		%	6.0%	1.5%	0.0%	7.7%	2.6%	
Total		Count	67	201	31	13	312	
		%	100.0%	100.0%	100.0%	100.0%	100.0 %	

Table 9: Relationship between BMI (WHO) and Acne grading

Crosstab – BMI (Asian-Pacific) and Acne grading								
			GRADING					
			GRADE 1	GRADE 2	GRADE 3	GRADE 4	Total	
Cat	Underweight <18.5	Count	17	30	7	5	59	$\chi 2$=14.707, p= .099
		%	25.4%	14.9%	22.6%	38.5%	18.9%	
	Normal weight (18.5-22.9)	Count	27	108	16	4	155	
		%	40.3%	53.7%	51.6%	30.8%	49.7%	
	Overweight (23.0-24.9)	Count	5	26	3	3	37	
		%	7.5%	12.9%	9.7%	23.1%	11.9%	
	Obese >25	Count	18	37	5	1	61	
		%	26.9%	18.4%	16.1%	7.7%	19.6%	
Total		Count	67	201	31	13	312	
		%	100.0%	100.0%	100.0%	100.0%	100.0 %	

Table 10: Relationship between BMI (Asian-Pacific) and Acne grading

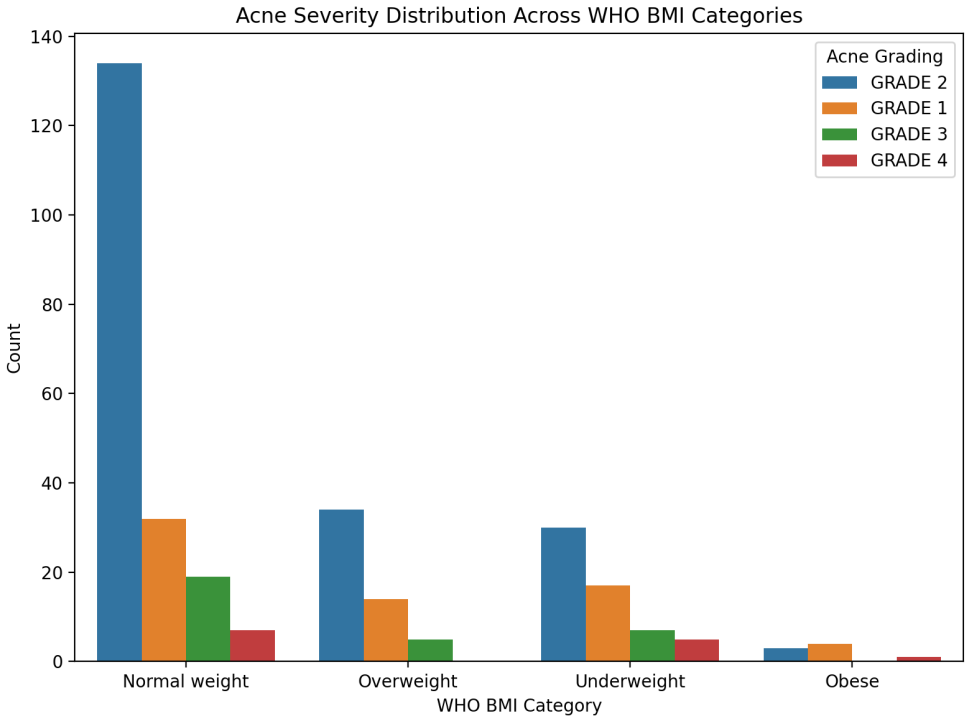

Figure 7: Acne severity distribution across WHO BMI categories

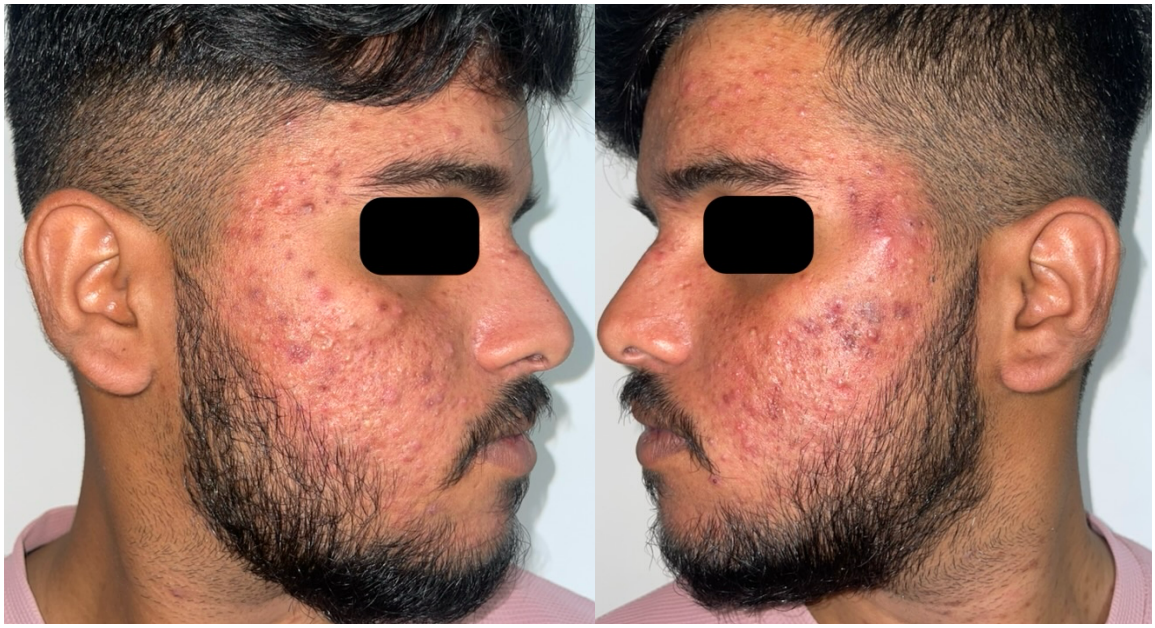

Figure 8: Patient with Grade 2 Acne Vulgaris

⇒ **ANOVA & Post Hoc Comparisons for BMI Across Age Groups**

- ANOVA results ($F = 18.363$, $p < 0.001$) suggest a significant BMI difference among age groups**.**

Age Group	N	Mean BMI	Std. Deviation	F	p-value
≤22	188	20.60	3.37	18.363	**<0.001**
23-27	71	22.35	3.72		
28-32	31	24.35	4.03		
33+	22	24.64	2.54		

Table 11: ANOVA for BMI Across Age Groups

- Post hoc **Bonferroni test** revealed:
    - Participants aged ≤22 had significantly lower BMI compared to older age groups ($p < 0.05$).
    - No significant difference in BMI between age groups 28-32 and 33+**.**

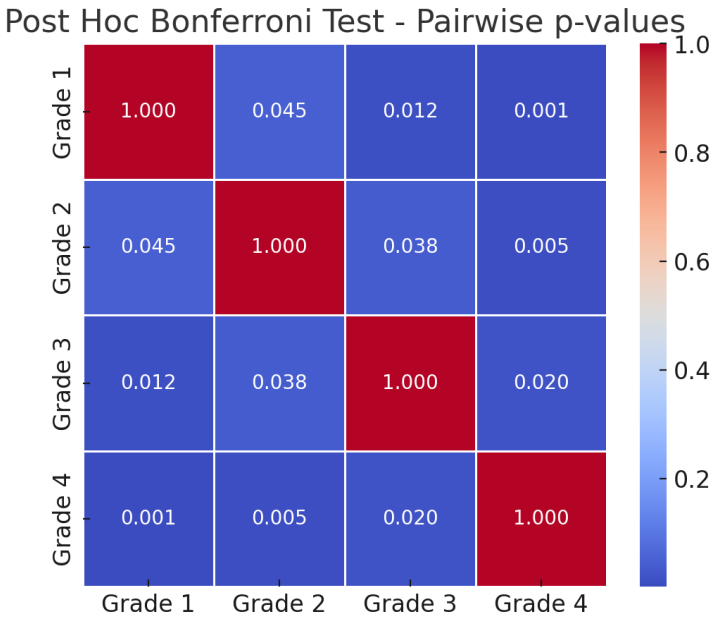

Figure 9: Heatmap for the Post Hoc Bonferroni test

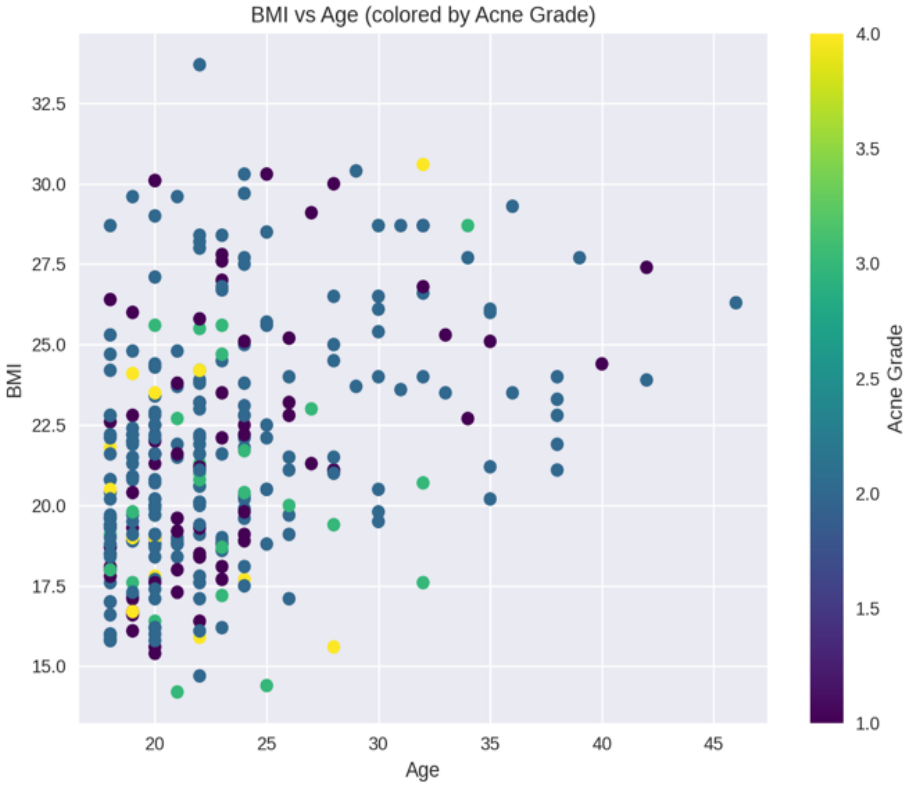

Figure 10: BMI vs Age (colour graded)

⇒ **Independent Samples T-Test for BMI Comparison**

- **Gender-Based Comparison:** No significant BMI difference between males (M = 21.50) and females (M = 21.77)**.** T-test (t = -0.629, p = 0.530) shows no statistically significant difference**.**

GENDER	N	Mean	Std. Deviation	t-test
Male	133	21.504	3.4648	(t = -0.629, p = 0.530)
Female	179	21.774	3.9630	

Table 12: Independent Samples T-Test for BMI Comparison between genders

- **Cases vs. Controls:** Mean BMI was lower in cases (21.659) than in controls (22.294)**.** T-test (t = -2.151, p = 0.032) suggests a statistically significant difference, indicating that acne cases tend to have slightly lower BMI.

	N	Mean	Std. Deviation	t-test
Cases	312	21.659	3.7553	(t = -2.151, p = 0.032)
Controls	312	22.294	3.6222	

Table 13: Independent Samples T-Test for BMI Comparison in Cases and Controls

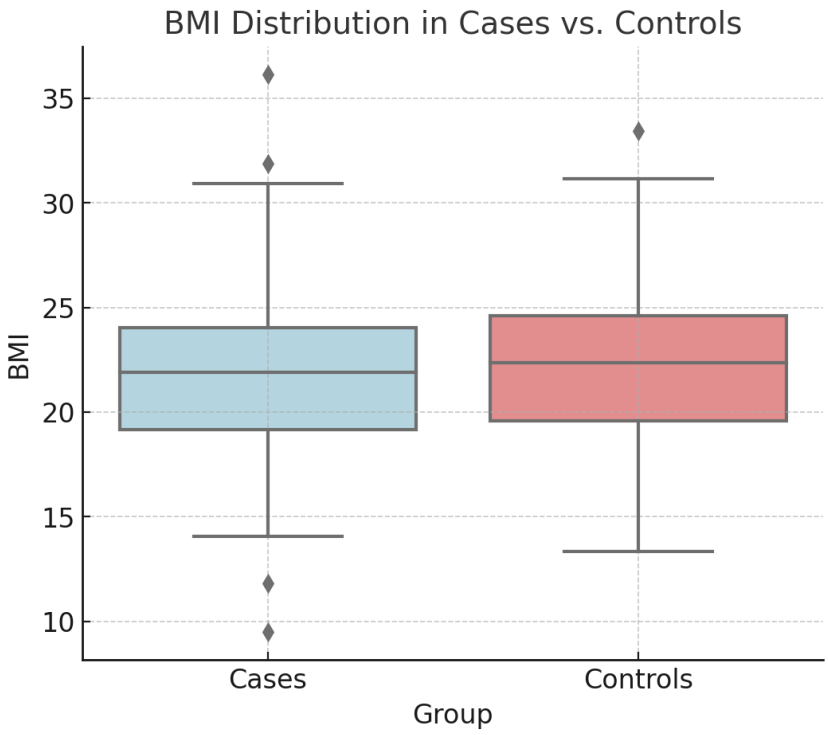

Figure 11: Box – plot showing BMI distribution in cases and controls

DISCUSSION:

Demographic Characteristics and Acne Vulgaris

The present study, conducted at Shri BM Patil Medical College between May 2023 and January 2025, offers valuable insights into the association between body mass index (BMI) and acne vulgaris in an adult population from North Karnataka, India. This investigation included 312 cases of acne vulgaris and 312 age-matched controls, with a primary focus on exploring the interplay between anthropometric parameters and acne severity within a South Asian context.

Age and Gender Distribution

The demographic analysis revealed a mean age of 23.08 ± 5.23 years for cases compared to 25.03 ± 5.08 years for controls. The majority of acne cases (60.3%) clustered in the younger age group (≤22 years), with progressively fewer cases in older cohorts. This age distribution aligns with established patterns in acne epidemiology, wherein prevalence peaks in late adolescence and gradually declines thereafter. Similar trends have been documented by Shen *et al*., in a large Chinese study, where acne prevalence was highest among 19-year-olds (46.8%) before steadily decreasing with advancing age.[140]

Our findings demonstrated a female preponderance among acne patients, with a female-to-male ratio of 1.35:1. This gender distribution corresponds with contemporary epidemiological data suggesting that adult acne disproportionately affects women. Collier *et al.,* reported that the prevalence of acne in women aged 20-29 years was 50.9%, compared to significantly lower rates in their male counterparts.[7] The higher incidence of acne in adult females may be attributed to various factors, including hormonal fluctuations related to

menstrual cycles, increased sensitivity to androgen receptor stimulation despite normal circulating androgen levels, and the influence of cosmetic products.

The predominance of females in our acne cohort is particularly noteworthy in the context of South Asian populations, where sociocultural factors may influence healthcare-seeking behaviors differently across genders. This pattern contrasts with some studies from East Asian populations, where male predominance in adolescent acne has been reported.[153]

Relationship Between BMI and Acne Vulgaris

BMI Comparison Between Cases and Controls

One of the most significant findings of our study is the observation that acne cases exhibited a lower mean BMI (21.659 ± 3.76 kg/m²) compared to controls (22.294 ± 3.62 kg/m²), with this difference reaching statistical significance ($t = -2.151$, $p = 0.032$). This contrasts with several previous investigations that reported positive associations between elevated BMI and acne prevalence or severity. For instance, Lu *et al*., found a positive correlation between overweight status and acne severity among Chinese adolescents (OR = 5.027, 95% CI 2.758-9.162, $p < 0.001$).[153]

When applying WHO BMI classification criteria, we observed a statistically significant difference in BMI distribution between cases and controls ($\chi^2 = 7.932$, $p = 0.047$). Notably, a higher proportion of controls (23.7%) were classified as overweight compared to cases (17.0%), while obesity was more prevalent among cases (2.6%) than controls (1.0%). This finding suggests a non-linear relationship between BMI and acne in our population.

Our findings of lower BMI in acne cases align with those of Alowairdhi *et al*., who conducted a hospital-based retrospective study in Saudi Arabia and similarly found that acne

patients had a significantly lower mean BMI than controls (25.2 vs. 26.3 kg/m², $p < 0.05$).[110] They also parallel the observations of Lu & Hsu, who reported an inverse association between BMI and acne lesion counts in Taiwanese women with post-adolescent acne.[153] These concordant findings across different Asian populations suggest the possibility of shared biological mechanisms that may differentiate acne pathophysiology in Asian versus Western populations.

Interestingly, when Asian BMI classification criteria were applied, the association between BMI categories and acne was no longer statistically significant ($\chi^2 = 5.635$, $p = 0.131$). This discrepancy highlights the critical importance of utilizing ethnically appropriate BMI classification systems when investigating metabolic-dermatological relationships in South Asian populations, as suggested by Misra *et al*.[11,12]

BMI and Acne Severity

Our analysis of the relationship between BMI and acne severity revealed intriguing patterns. When utilizing WHO BMI classification, a statistically significant association was observed between BMI categories and acne severity grades ($\chi^2 = 17.952$, $p = 0.036$). Notably, underweight individuals (BMI < 18.5 kg/m²) constituted the highest proportion (38.5%) of patients with Grade 4 (severe) acne. This finding differs from earlier studies by Kane et al., Adityan et al., and Shen et al., where Grade 1 acne (predominantly comedonal and superficial inflammatory sub-type) was significantly more prevalent than severe inflammatory forms.[47,140,154]

The association between underweight status and severe acne observed in our study presents an intriguing finding that warrants careful consideration. This relationship may be mediated by nutritional factors, as suggested by Gayen *et al.*, who found that inadequate intake of

essential micronutrients and fatty acids could potentially compromise skin barrier function and exacerbate inflammatory responses.[114]

The complex relationship between BMI and acne severity observed in our study differs from findings of Öztelcan Gündüz & Ataş (2023), who investigated the relationship between BMI z-scores and acne severity in Turkish adolescents and demonstrated that patients with moderate/severe acne had significantly higher BMI z-scores than those with mild acne.[155]

Age, BMI, and Acne: Exploring Relationships

Our ANOVA analysis revealed significant differences in BMI across age groups ($F = 18.363$, $p < 0.001$), with younger participants (≤22 years) exhibiting significantly lower BMI compared to older age cohorts. These findings reflect normal developmental patterns of body composition changes across the lifespan, characterized by progressive increases in fat mass relative to lean mass with advancing age Tsai *et al*.[106] The observed age-related BMI differences in our cohort may partially explain the higher prevalence of acne in younger age groups, as lower BMI was associated with increased acne prevalence in our population.

The interaction between age, BMI, and acne is complex and likely modulated by hormonal factors, as suggested by Del Rosso & Kircik.[156] Adolescence and early adulthood are characterized by significant hormonal fluctuations, particularly involving androgens, which stimulate sebaceous gland activity and sebum production. The influence of these hormonal factors on acne pathogenesis may be more pronounced in younger individuals, potentially modifying the effects of BMI on acne development and severity.[15,55,56]

Gender, BMI, and Acne

Our analysis found no significant difference in BMI between male (21.50 ± 3.46 kg/m²) and female (21.77 ± 3.96 kg/m²) acne patients (t = -0.629, p = 0.530). This finding suggests that while gender significantly influences acne prevalence, as evidenced by the female predominance in our cohort, this effect may not be mediated through differences in BMI. Rather, gender-specific hormonal profiles and their effects on sebaceous gland function likely play a more direct role in determining acne susceptibility and presentation, as proposed by Kurokawa *et al*.[52]

The similar BMI distribution across genders in our acne cohort contrasts with typical population patterns in South Asia, where gender disparities in BMI are often observed due to sociocultural factors influencing diet, physical activity, and body image as explained by Misra et al.[12,24] This finding raises the interesting possibility that individuals with acne might share certain metabolic characteristics regardless of gender, possibly related to androgen sensitivity, insulin signaling, or inflammatory responses.[14,54,57,58]

Implications of WHO versus Asian BMI Classification Systems

A noteworthy aspect of our study is the differential associations observed when applying WHO versus Asian-specific BMI classification systems. Under WHO criteria, statistically significant relationships were detected between BMI categories and both acne presence (p = 0.047) and severity (p = 0.036). However, these associations did not reach statistical significance when using Asian-specific BMI thresholds (p = 0.131 for acne presence; p = 0.099 for acne severity).

This discrepancy underscores the critical importance of employing ethnically appropriate BMI classification systems in South Asian populations, a consideration that has been largely overlooked in previous acne-BMI research. The reduced statistical significance observed

with Asian-specific BMI thresholds might reflect a more nuanced and accurate representation of the relationship between adiposity and acne in our population, highlighting the limitations of applying Western-derived BMI cutoffs to South Asian subjects.

Pathophysiological Considerations

The inverse relationship between BMI and acne observed in our study challenges some prevailing hypotheses regarding the pathophysiological links between adiposity and acne. Several mechanisms warrant consideration in interpreting these findings.

Adipose tissue functions as an active endocrine organ, influencing hormonal balance through multiple pathways. In individuals with higher BMI, increased aromatase activity in adipose tissue converts androgens to estrogens, potentially resulting in lower androgen-to-estrogen ratios.[55,56,157] Since estrogens reduce sebum production and counteract androgen effects on sebaceous glands, this hormonal shift might confer relative protection against acne in individuals with higher BMI, a mechanism that could explain our findings.

Chronic low-grade inflammation characterizes both obesity and acne, albeit through potentially different pathways. The interplay between these inflammatory processes in individuals with varying BMI is complex and incompletely understood, particularly in South Asian populations where specific cytokine profiles may differ from those observed in Western cohorts.[17,61,131]

Beyond quantitative changes in sebum production, qualitative alterations in sebum composition may link BMI status and acne development. Ottaviani *et al.* demonstrated that acne patients exhibit specific lipidomic signatures in sebum, characterized by altered ratios of saturated to unsaturated fatty acids and modified squalene metabolism.[158] The inverse

relationship between BMI and acne observed in our study might reflect BMI-related differences in sebum composition rather than total sebum production.

Implications and Future Directions

Our findings have several important clinical implications for dermatological practice in South Asian contexts. The observed inverse relationship between BMI and acne prevalence in our population suggests that leaner individuals may require more vigilant monitoring for acne development and progression. This contrasts with prevailing clinical assumptions that often associate higher BMI with increased acne risk.

The differential associations observed with WHO versus Asian-specific BMI classifications emphasize the importance of utilizing ethnically appropriate anthropometric references in clinical assessment. Our findings challenge simplistic approaches to nutritional counseling for acne patients, suggesting that dietary advice should be nuanced and individualized, considering the complex interplay between BMI, nutritional status, hormonal balance, and acne pathogenesis.

Future research should incorporate detailed assessment of body composition, including regionalized adiposity measurements and direct quantification of body fat percentage, to enhance understanding of the specific aspects of body habitus most relevant to acne pathogenesis. Longitudinal studies tracking changes in both BMI and acne severity over time would provide valuable insights into the temporal relationship between these factors and potential causality.

Finally, interventional studies examining the impact of weight-modifying interventions (for both underweight and overweight individuals) on acne outcomes would provide valuable

clinical insights with direct therapeutic implications, potentially leading to novel preventive and therapeutic approaches for acne vulgaris, particularly in South Asian populations.

Study Strengths and Limitations

Strengths

1. It addresses a significant knowledge gap regarding BMI-acne relationships in South Asian populations, who have been underrepresented in previous research despite their distinct anthropometric and metabolic characteristics.
2. Our comparative analysis of WHO versus Asian-specific BMI classification systems provides valuable insights into the importance of ethnically appropriate anthropometric references in dermatological research.
3. Our study included a relatively large sample size with well-matched cases and controls, enhancing the reliability of our findings.

Limitations

1. Findings may not be fully generalizable to the broader population of North Karnataka or other regions of India.
2. Cross-sectional design restricts determination of causality in the observed relationships.
3. Anthropometric measures such as waist circumference or direct measures of body composition, which might have provided more comprehensive insights into the relationship between adiposity distribution and acne.
4. Detailed hormonal, nutritional, and lifestyle assessments were beyond the scope of this study, limiting our ability to elucidate specific mechanisms underlying the observed associations.

CONCLUSION:

This study provides novel evidence of an inverse relationship between BMI and both acne prevalence and severity in an adult population from North Karnataka, India. Our findings challenge some prevailing assumptions regarding adiposity-acne relationships derived predominantly from Western populations, highlighting the importance of population-specific research in dermatology.

The significant associations observed using WHO BMI classifications, which became non-significant when applying Asian-specific thresholds, emphasize the critical importance of utilizing ethnically appropriate anthropometric references in both research and clinical practice. The higher prevalence of severe acne among underweight individuals in our cohort suggests that nutritional factors and hormonal factors may play an important role in acne pathogenesis in this population.

These findings contribute to the growing body of evidence regarding the complex interplay between metabolic factors and dermatological health in diverse populations. Further research into the specific mechanisms underlying these associations may lead to novel preventive and therapeutic approaches for acne vulgaris, particularly in South Asian population.

SUMMARY :

This hospital-based cross-sectional case-control study conducted at Shri BM Patil Medical College Hospital in North Karnataka, India (May 2023-January 2025) included 312 acne cases and 312 age-matched controls. BMI was classified using both WHO and Asian criteria, with acne severity assessed via the Pillsbury grading system.

The mean age of cases was 23.08 ± 5.23 years (vs. 25.03 ± 5.08 for controls), with 60.3% of cases in the ≤22 age group. A female predominance was observed (female-to-male ratio: 1.35:1), though no significant BMI difference existed between genders ($p = 0.530$).

Acne cases demonstrated significantly lower mean BMI (21.659) compared to controls (22.294) ($p = 0.032$). Under WHO classification, a statistically significant difference in BMI distribution was observed ($p = 0.047$), with controls having higher rates of overweight status (23.7% vs 17.0% in cases). Using Asian BMI criteria, this association became non-significant ($p = 0.131$).

Grade 2 acne predominated (64.4% of cases), with underweight individuals comprising 38.5% of severe (Grade 4) acne cases. A significant association between WHO BMI categories and acne severity emerged ($p = 0.036$), though this relationship lost significance with Asian BMI criteria ($p = 0.099$).

ANOVA revealed significant age-related BMI differences ($p < 0.001$), with younger participants showing lower BMI values. This study presents novel evidence of an inverse relationship between BMI and both acne prevalence and severity, with underweight status particularly associated with severe presentations.

These findings suggest that leaner individuals may require closer monitoring for acne development, ethnically appropriate BMI classifications should be utilized in clinical

assessment, and nutritional evaluation may be valuable for patients with severe acne and low BMI. The results challenge simplistic approaches to nutritional counseling for acne patients and highlight the importance of population-specific research in dermatology.

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ANNEXURE I

BLDE
(DEEMED TO BE UNIVERSITY)
Declared as Deemed to be University u/s 3 of UGC Act, 1956
Accredited with 'A' Grade by NAAC (Cycle-2)
The Constituent College
SHRI B. M. PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, VIJAYAPURA

BLDE (DU)/IEC/ 883/2022-23 10/4/2023

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this University met on **Saturday, 18th March, 2023 at 11.30 a.m. in the CAL Laboratory, Dept. of Pharmacology,** scrutinizes the Synopsis/ Research Projects of Post Graduate Student / Under Graduate Student /Faculty members of this University /Ph.D. Student College from ethical clearance point of view. After scrutiny, the following original/ corrected and revised version synopsis of the thesis/ research projects has been accorded ethical clearance.

TITLE: "ASSOCIATION BETWEEN ACNE VULGARIS AND BODY MASS INDEX IN ADULT POPULATION: A TERTIARY HOSPITAL-BASED PROSPECTIVE STUDY IN NORTH KARNATAKA, INDIA".

NAME OF THE STUDENT/PRINCIPAL INVESTIGATOR: DR.TVISHA PRASAD

NAME OF THE GUIDE: DR.ARUN C.INAMADAR, PROFESSOR,
DEPT. OF DERMATOLOGY, VENEROLOGY AND LEPROSY.

Dr. Santoshkumar Jeevangi
Chairperson
IEC, BLDE (DU),
VIJAYAPURA
Chairman,
Institutional Ethical Committee,
BLDE (Deemed to be University)
Vijayapura

Dr.Akram A.Naikwadi
Member Secretary
IEC, BLDE (DU),
VIJAYAPURA
MEMBER SECRETARY
Institutional Ethics Committee
BLDE (Deemed to be University)
Vijayapura-586103, Karnataka

Following documents were placed before Ethical Committee for Scrutinization.

- Copy of Synopsis/Research Projects
- Copy of inform consent form
- Any other relevant document

Smt. Bangaramma Sajjan Campus, B. M. Patil Road (Sholapur Road), Vijayapura - 586103, Karnataka, India.
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College: Phone: +918352-262770, Fax: +918352-263019, E-mail: bmpmc.principal@bldedu.ac.in

ANNEXURE II

B.L.D.E. (Deemed to be University)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE,VIJAYAPURA.

DEPARTMENT OF DERMATOLOGY, VENEREOLOGY, AND LEPROSY

SCHEME OF CASE TAKING

ASSOCIATION BETWEEN ACNE VULGARIS AND BODY MASS INDEX IN ADULT POPULATION: A TERTIARY HOSPITAL-BASED PROSPECTIVE STUDY IN NORTH KARNATAKA, INDIA.

S.No: Date:

Name: Hospital Number:

Age / Sex: Occupation:

Address and Contact Details:

Presenting Complaints & duration:

History of Present Illness:

Personal History:

Past History:

Family History:

General Physical Examination:

Height: Weight:

Cutaneous Examination:

Skin type –

Skin color/phototype -

Distribution of acne- Face

-Neck, chest, back, upper arms

-Lesion morphology

Grade of Acne:

Provisional Diagnosis:

Remarks:

ANNEXURE III

B.L.D.E. (Deemed to be University)

SHRI B. M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE,VIJAYAPURA.

DEPARTMENT OF DERMATOLOGY, VENEREOLOGY, AND LEPROSY

INFORMED CONSENT FORM

TITLE OF RESEARCH : Association Between Acne Vulgaris and Body Mass Index in Adult Population: A Tertiary Hospital-Based Prospective Study in North Karnataka, India

GUIDE : DR. ARUN C. INAMADAR

P.G. STUDENT : DR. TVISHA PRASAD

PURPOSE OF RESEARCH:

I have been informed that this project will study Association Between Acne Vulgaris and Body Mass Index in Adult Population: A Tertiary Hospital-Based Prospective Study in North Karnataka, India at Shri BM Patil Medical College and Research Centre, VIJAYAPURA.

BENEFITS:

I understand that my participation in this study will help the investigator to know the correlation of BMI and Acne Vulgaris.

PROCEDURE:

I understand that relevant history will be taken for the study with answers to a few important questions and that the personal data will be protected.

CONFIDENTIALITY:

I understand that medical information produced by this study will become a part of my hospital records and will be subjected to the confidentiality and privacy regulation of the said hospital. Information of a sensitive personal nature will not be a part of the medical records

but will be stored in the investigator's research file.

If the data are used for publication in the medical literature or for teaching purposes no names will be used and other identifiers such as photographs and audio or video tapes will be used only with my special written permission. I understand I may see the photographs, videotapes, and hear the audiotapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time concerned. Dr. Tvisha Prasad is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of this study, which may influence my continued participation.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in this study at any time without prejudice. I also understand that Dr. Tvisha Prasad may terminate my participation in this study at any time after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me resulting directly from my participation in this study and if such injury were reported promptly, then medical treatment will be available to me, but no further compensation will be provided. I understand that by my agreement for my participation in this study, I am not waiving any of my legal rights.

I have explained to (patient's / relevant guardian's name) the purpose of the research, the procedures required, and the possible risks and benefits to the best of my ability in the patient's own language.

_____ _____

Investigator / P. G. Guide Date

ANNEXURE IV

KEY TO MASTER CHART

GRPA 1 - CASES

GRPA 2 – CONTROLS

BMI – Body mass index

Weight(kg) - Weight in kilograms

Height (m) – Height in meters

ANNEXURE V- MASTER CHART

S.No	Name	ID	GRADING	GRPA	AGE	SEX	Weight (kg)	Height (m)	BMI	WHO BMI Category	Asian BMI Category
1	PRIYANKA YA	292982	GRADE 2	1	19	Female	49	1.53	20.9	Normal weight	Normal weight
2	PRATIK BIRAD	237841	GRADE 2	1	23	Male	70	1.69	24.5	Normal weight	Overweight
3	GIRIJA MANG	282774	GRADE 2	1	19	Female	74	1.58	29.6	Overweight	Obese
4	JAVED PATEL	232548	GRADE 2	1	21	Male	50	1.3	29.6	Overweight	Obese
5	SHASHANK	255770	GRADE 2	1	21	Male	67	1.68	23.7	Normal weight	Overweight
6	VINAYAK	270492	GRADE 2	1	18	Male	47	1.55	19.6	Normal weight	Normal weight
7	RENUKA	168480	GRADE 1	1	18	Female	55	1.56	22.6	Normal weight	Normal weight
8	KAVERI	222496	GRADE 2	1	25	Female	68	1.63	25.6	Overweight	Obese
9	DHRUV	219164	GRADE 2	1	18	Male	45	1.55	18.7	Normal weight	Normal weight
10	SUNIL	217241	GRADE 2	1	18	Male	42	1.57	17	Underweight	Underweight
11	NISCHITHA	10968	GRADE 2	1	23	Female	48	1.59	19	Normal weight	Normal weight
12	ALOK	206048	GRADE 2	1	18	Male	78	1.65	28.7	Overweight	Obese
13	IRAMMA	204588	GRADE 2	1	21	Female	43	1.53	18.4	Underweight	Underweight
14	PADMASHRE	153379	GRADE 2	1	28	Female	48	1.51	21.1	Normal weight	Normal weight
15	SHRUJA	148228	GRADE 3	1	18	Male	57	1.72	19.3	Normal weight	Normal weight
16	RASHUL	139949	GRADE 2	1	19	Male	65	1.72	22	Normal weight	Normal weight
17	YUNUS	169014	GRADE 2	1	18	Male	48	1.7	16.6	Underweight	Underweight
18	RADHIKA	126509	GRADE 2	1	18	Female	45	1.56	18.5	Normal weight	Normal weight
19	RAJENDRA	126113	GRADE 2	1	20	Male	81	1.67	29	Overweight	Obese
20	VAISHNAVI	125251	GRADE 1	1	20	Female	48	1.5	21.3	Normal weight	Normal weight
21	FAROOQ	125162	GRADE 3	1	22	Male	61	1.72	20.6	Normal weight	Normal weight
22	SHABNAM	89679	GRADE 2	1	42	Female	56	1.53	23.9	Normal weight	Overweight
23	KUMAR IRAPI	123807	GRADE 2	1	18	Male	51	1.62	19.4	Normal weight	Normal weight
24	BHUVANESH	104420	GRADE 2	1	21	Female	45	1.54	19	Normal weight	Normal weight
25	ARUN	111740	GRADE 2	1	18	Male	59	1.7	20.4	Normal weight	Normal weight
26	PRERANA	351020	GRADE 3	1	20	Female	41	1.58	16.4	Underweight	Underweight
27	SOHEL	324101	GRADE 2	1	20	Male	56	1.64	20.8	Normal weight	Normal weight
28	SOUMYA	238842	GRADE 1	1	21	Female	46	1.6	18	Underweight	Underweight
29	KAVYA	253235	GRADE 2	1	22	Female	43	1.5	19.1	Normal weight	Normal weight
30	MAHESH	351893	GRADE 2	1	20	Male	66	1.68	23.4	Normal weight	Overweight

31	DANESH	251621	GRADE 2	1	19	Male	52	1.58	20.8	Normal weight	Normal weight
32	JYOTI	380861	GRADE 2	1	30	Female	65	1.6	25.4	Overweight	Obese
33	ABDUAL	389113	GRADE 4	1	18	Male	70	1.79	21.8	Normal weight	Normal weight
34	RENUKA	332513	GRADE 2	1	18	Female	45	1.47	20.8	Normal weight	Normal weight
35	BHOOMIKA	327412	GRADE 4	1	20	Female	55	1.53	23.5	Normal weight	Overweight
36	SUVARNA	42650	GRADE 2	1	33	Female	50	1.46	23.5	Normal weight	Overweight
37	SHANTA	226847	GRADE 2	1	19	Female	50	1.5	22.2	Normal weight	Normal weight
38	ROOPALI	338955	GRADE 2	1	20	Female	55	1.55	22.9	Normal weight	Normal weight
39	VAISHNAVI	330007	GRADE 1	1	23	Female	60	1.49	27	Overweight	Obese
40	AJADA INAMA	151109	GRADE 2	1	18	Female	40	1.59	15.8	Underweight	Underweight
41	SHIVA	313438	GRADE 2	1	38	Male	61	1.67	21.9	Normal weight	Normal weight
42	AJAYA	304895	GRADE 2	1	23	Male	72	1.64	26.8	Overweight	Obese
43	KANABAI	7991	GRADE 2	1	19	Female	50	1.5	22.2	Normal weight	Normal weight
44	VENKATESH	93361	GRADE 2	1	20	Male	55	1.71	18.8	Normal weight	Normal weight
45	SANIYA	92062	GRADE 1	1	18	Female	51	1.68	18.1	Underweight	Underweight
46	LEENA	85201	GRADE 1	1	19	Female	55	1.64	20.4	Normal weight	Normal weight
47	SIDDAMMA	80525	GRADE 2	1	28	Female	57	1.51	25	Overweight	Obese
48	ANAMIKA	78430	GRADE 1	1	19	Female	44	1.51	19.3	Normal weight	Normal weight
49	UMESH	77719	GRADE 4	1	20	Male	54	1.74	17.8	Underweight	Underweight
50	NOORNADA	77701	GRADE 1	1	23	Male	67	1.69	23.5	Normal weight	Overweight
51	SONIYA	74867	GRADE 1	1	23	Female	50	1.63	18.8	Normal weight	Normal weight
52	RAHUL	54811	GRADE 3	1	22	Male	60	1.68	21.3	Normal weight	Normal weight
53	RAESHWARI	320128	GRADE 2	1	22	Male	50	1.5	22.2	Normal weight	Normal weight
54	LAXMI	232372	GRADE 2	1	21	Female	58	1.53	24.8	Normal weight	Overweight
55	TEJASHWINI	269881	GRADE 2	1	26	Female	38	1.49	17.1	Underweight	Underweight
56	PUSHPA	49393	GRADE 2	1	31	Female	68	1.54	28.7	Overweight	Obese
57	AKSHATA	41460	GRADE 1	1	25	Female	70	1.52	30.3	Obese	Obese
58	VINODA	40036	GRADE 1	1	40	Female	55	1.5	24.4	Normal weight	Overweight
59	ASHWINI	85531	GRADE 2	1	30	Female	60	1.58	24	Normal weight	Overweight
60	ANADA	418634	GRADE 2	1	21	Male	50	1.63	18.8	Normal weight	Normal weight

61	SHARANBASI	19145	GRADE 2	1	21	Male	68	1.78	21.5	Normal weight	Normal weight
62	VIDYASHREE	305399	GRADE 2	1	18	Female	50	1.55	20.8	Normal weight	Normal weight
63	TEJASHWINI	405905	GRADE 1	1	22	Female	47	1.56	19.3	Normal weight	Normal weight
64	PRADEEP	405387	GRADE 3	1	23	Male	44	1.6	17.2	Underweight	Underweight
65	MAITRA	404240	GRADE 1	1	19	Female	38	1.51	16.7	Underweight	Underweight
66	PRERANA	398850	GRADE 2	1	19	Female	48	1.56	19.7	Normal weight	Normal weight
67	YALLAMMA	397182	GRADE 2	1	30	Female	48	1.53	20.5	Normal weight	Normal weight
68	DARSHAN	396240	GRADE 2	1	19	Male	57	1.61	22	Normal weight	Normal weight
69	AYUSH	375772	GRADE 2	1	20	Male	71	1.71	24.3	Normal weight	Overweight
70	PREETI	374277	GRADE 2	1	23	Female	54	1.58	21.6	Normal weight	Normal weight
71	PRASAN	369197	GRADE 3	1	22	Male	79	1.76	25.5	Overweight	Obese
72	BIBISHAKINA	293954	GRADE 2	1	46	Female	64	1.56	26.3	Overweight	Obese
73	POOJA	342563	GRADE 3	1	23	Female	64	1.58	25.6	Overweight	Obese
74	SHANTAVEER	340592	GRADE 1	1	26	Male	72	1.69	25.2	Overweight	Obese
75	MALIK	335507	GRADE 3	1	18	Male	50	1.62	19.1	Normal weight	Normal weight
76	MANOJ	326038	GRADE 2	1	26	Male	57	1.63	21.5	Normal weight	Normal weight
77	LAXMI	310254	GRADE 2	1	22	Female	42	1.69	14.7	Underweight	Underweight
78	VINCY	100718	GRADE 2	1	24	Female	73	1.63	27.5	Overweight	Obese
79	AMBRISH	3000085	GRADE 2	1	25	Male	58	1.68	20.5	Normal weight	Normal weight
80	BABUGOUDA	291461	GRADE 2	1	22	Male	54	1.64	20.1	Normal weight	Normal weight
81	VEERESH	23423	GRADE 2	1	24	Male	64	1.7	22.1	Normal weight	Normal weight
82	ABHISHEK	192032	GRADE 1	1	18	Male	46	1.57	18.7	Normal weight	Normal weight
83	NEHA	275005	GRADE 2	1	24	Female	48	1.54	20.2	Normal weight	Normal weight
84	AISHWARYA	274377	GRADE 1	1	20	Female	80	1.63	30.1	Obese	Obese
85	BASAVRAJ	121523	GRADE 1	1	20	Male	62	1.68	22	Normal weight	Normal weight
86	KAINATH	266930	GRADE 2	1	22	Female	49	1.56	20.1	Normal weight	Normal weight
87	SHAKUNTHAI	265897	GRADE 2	1	35	Female	57	1.48	26	Overweight	Obese
88	SPURTI	251666	GRADE 2	1	19	Female	42	1.49	18.9	Normal weight	Normal weight
89	PRASHANT	247394	GRADE 2	1	22	Male	66	1.79	20.6	Normal weight	Normal weight
90	RESHMA	246988	GRADE 2	1	28	Female	62	1.59	24.5	Normal weight	Overweight

91	LAXMI	245550	GRADE 2	1	19	Female	46	1.56	18.9	Normal weight	Normal weight
92	DARSHAN	245551	GRADE 1	1	18	Male	54	1.73	18	Underweight	Underweight
93	JYOTI	239782	GRADE 2	1	20	Female	43	1.56	17.7	Underweight	Underweight
94	MANJULA	233946	GRADE 1	1	35	Female	58	1.52	25.1	Overweight	Obese
95	MANJULA	231953	GRADE 2	1	25	Female	39	1.44	18.8	Normal weight	Normal weight
96	SHRIKARNE	229790	GRADE 2	1	25	Male	52	1.52	22.5	Normal weight	Normal weight
97	KAVITA	226559	GRADE 1	1	26	Female	52	1.51	22.8	Normal weight	Normal weight
98	SAGAR	222951	GRADE 3	1	22	Male	60	1.69	21	Normal weight	Normal weight
99	AKSHATA	41411	GRADE 3	1	19	Female	45	1.6	17.6	Underweight	Underweight
100	DHRAKSHAY.	206839	GRADE 1	1	27	Male	46	1.47	21.3	Normal weight	Normal weight
101	SAHEBGOUD	182369	GRADE 3	1	23	Male	68	1.66	24.7	Normal weight	Overweight
102	VAISHNAVI	16915	GRADE 1	1	19	Female	57	1.58	22.8	Normal weight	Normal weight
103	MAHANTESH	165810	GRADE 2	1	18	Male	59	1.77	18.8	Normal weight	Normal weight
104	SPOORTI	102341	GRADE 1	1	23	Female	51	1.68	18.1	Underweight	Underweight
105	AKASH	157165	GRADE 2	1	18	Male	68	1.64	25.3	Overweight	Obese
106	JYOTHI	157167	GRADE 2	1	19	Female	47	1.5	20.9	Normal weight	Normal weight
107	ANILGOUDA	156502	GRADE 2	1	19	Male	60	1.67	21.5	Normal weight	Normal weight
108	SUSHMITA	155953	GRADE 1	1	22	Female	42	1.51	18.4	Underweight	Underweight
109	ABHISHEK	80460	GRADE 3	1	21	Male	64	1.68	22.7	Normal weight	Normal weight
110	SANDEEPA	148541	GRADE 2	1	18	Male	44	1.66	16	Underweight	Underweight
111	YASMEEN	145481	GRADE 1	1	28	Female	50	1.54	21.1	Normal weight	Normal weight
112	SHIVALEELA	144248	GRADE 2	1	26	Female	54	1.5	24	Normal weight	Overweight
113	VIJAYALAKSH	140584	GRADE 2	1	20	Female	36	1.49	16.2	Underweight	Underweight
114	VITHAL	139481	GRADE 2	1	24	Male	58	1.69	20.3	Normal weight	Normal weight
115	BHAGYASHR	139413	GRADE 2	1	21	Female	52	1.54	21.9	Normal weight	Normal weight
116	SUREKHA	84944	GRADE 1	1	42	Female	65	1.54	27.4	Overweight	Obese
117	RAHUL	135723	GRADE 1	1	26	Male	64	1.66	23.2	Normal weight	Overweight
118	VIDYA	133917	GRADE 2	1	20	Female	46	1.55	19.1	Normal weight	Normal weight
119	MALLIKARJUN	123608	GRADE 1	1	19	Male	77	1.72	26	Overweight	Obese
120	SASHIKALA	122710	GRADE 1	1	23	Female	66	1.54	27.8	Overweight	Obese

121	NEELAMMA	74833	GRADE 2	1	18	Male	46	1.44	22.2	Normal weight	Normal weight
122	NAGRAJ	129395	GRADE 4	1	19	Male	55	1.51	24.1	Normal weight	Overweight
123	VISHWANATH	129394	GRADE 2	1	25	Male	76	1.72	25.7	Overweight	Obese
124	OMKAR	135126	GRADE 2	1	18	Male	48	1.59	19	Normal weight	Normal weight
125	ARATI	137600	GRADE 1	1	20	Female	40	1.45	19	Normal weight	Normal weight
126	VEENA	301602	GRADE 2	1	31	Female	43	1.35	23.6	Normal weight	Overweight
127	ARCHANA	155395	GRADE 2	1	24	Female	56	1.36	30.3	Obese	Obese
128	ANUSHA	94569	GRADE 2	1	22	Female	50	1.52	21.6	Normal weight	Normal weight
129	SHRISHAIL	130392	GRADE 2	1	18	Male	74	1.75	24.2	Normal weight	Overweight
130	SAVITRI	173948	GRADE 1	1	23	Female	42	1.38	22.1	Normal weight	Normal weight
131	BAVANI	202315	GRADE 2	1	20	Female	40	1.46	18.8	Normal weight	Normal weight
132	RAGHVENDR	212490	GRADE 2	1	19	Male	55	1.79	17.2	Underweight	Underweight
133	HARLABAI	212376	GRADE 3	1	34	Female	68	1.54	28.7	Overweight	Obese
134	NAZIYA	223784	GRADE 4	1	18	Female	48	1.53	20.5	Normal weight	Normal weight
135	ASLESHA	223919	GRADE 3	1	20	Female	48	1.56	19.7	Normal weight	Normal weight
136	JAYASHREE	407006	GRADE 4	1	32	Female	60	1.4	30.6	Obese	Obese
137	SANJAY	2387782	GRADE 2	1	18	Male	44	1.66	16	Underweight	Underweight
138	BASAVRAJ	229330	GRADE 1	1	20	Male	55	1.77	17.6	Underweight	Underweight
139	MOUNESH	241823	GRADE 2	1	21	Male	54	1.66	19.6	Normal weight	Normal weight
140	PRASHANT	244879	GRADE 2	1	23	Male	58	1.75	18.9	Normal weight	Normal weight
141	DEEPA	246815	GRADE 1	1	32	Female	68	1.54	28.7	Overweight	Obese
142	ANNAPURNA	253233	GRADE 2	1	22	Female	48	1.51	21.1	Normal weight	Normal weight
143	KAVYA	253235	GRADE 2	1	22	Female	64	1.5	28.4	Overweight	Obese
144	BASAVRAJ	70053	GRADE 1	1	24	Male	50	1.62	19.1	Normal weight	Normal weight
145	VINAYAK	287152	GRADE 2	1	20	Male	50	1.65	18.4	Underweight	Underweight
146	SONALI	350413	GRADE 2	1	20	Female	45	1.5	20	Normal weight	Normal weight
147	SOUMYA	367937	GRADE 1	1	22	Female	55	1.61	21.2	Normal weight	Normal weight
148	ANAND	369395	GRADE 2	1	24	Male	60	1.66	21.8	Normal weight	Normal weight
149	PAVITRI	396186	GRADE 2	1	20	Female	50	1.5	22.2	Normal weight	Normal weight
150	SUVARNA	42650	GRADE 2	1	36	Female	50	1.46	23.5	Normal weight	Overweight

151	ASHWINI	50561	GRADE 3	1	25	Female	36	1.58	14.4	Underweight	Underweight
152	BASANGOUD	118921	GRADE 2	1	22	Male	75	1.77	23.9	Normal weight	Overweight
153	BAVANI	202315	GRADE 1	1	21	Female	50	1.45	23.8	Normal weight	Overweight
154	LAXMI	251309	GRADE 4	1	20	Female	44	1.52	19	Normal weight	Normal weight
155	BASAVRAJ	48923	GRADE 2	1	24	Male	80	1.79	25	Overweight	Obese
156	ABHISHEK	220934	GRADE 2	1	23	Male	88	1.76	28.4	Overweight	Obese
157	VISHAVARAD	213887	GRADE 1	1	22	Male	64	1.66	23.2	Normal weight	Overweight
158	LAKSHMI	9407	GRADE 2	1	26	Female	46	1.53	19.7	Normal weight	Normal weight
159	AMRUTA	132931	GRADE 2	1	20	Female	37	1.51	16.2	Underweight	Underweight
160	DIVYA	199763	GRADE 2	1	18	Female	35	1.49	15.8	Underweight	Underweight
161	ADITI	189059	GRADE 1	1	19	Female	40	1.55	16.6	Underweight	Underweight
162	POOJA	290680	GRADE 1	1	22	Female	45	1.56	18.5	Normal weight	Normal weight
163	APOORVA	362147	GRADE 3	1	30	Female	68	1.54	28.7	Overweight	Obese
164	JYOTI	363330	GRADE 2	1	22	Female	53	1.55	22.1	Normal weight	Normal weight
165	VIJAYALAKSH	28822	GRADE 2	1	32	Female	60	1.58	24	Normal weight	Overweight
166	AMRUTA	20777	GRADE 2	1	35	Female	57	1.64	21.2	Normal weight	Normal weight
167	SHRIKANTH	141565	GRADE 2	1	38	Male	64	1.74	21.1	Normal weight	Normal weight
168	NAVEEN	285471	GRADE 2	1	24	Male	58	1.72	19.6	Normal weight	Normal weight
169	SHAHEEN	250435	GRADE 2	1	30	Female	50	1.6	19.5	Normal weight	Normal weight
170	SANDESH	292663	GRADE 2	1	22	Male	50	1.71	17.1	Underweight	Underweight
171	SOUMYA	19944	GRADE 2	1	24	Female	54	1.56	22.2	Normal weight	Normal weight
172	DIKSHA	343087	GRADE 2	1	18	Female	44	1.58	17.6	Underweight	Underweight
173	AMAR	172838	GRADE 2	1	18	Male	54	1.78	17	Underweight	Underweight
174	ROHINI	66109	GRADE 2	1	24	Female	50	1.48	22.8	Normal weight	Normal weight
175	GOURISH	209139	GRADE 2	1	22	Male	55	1.54	23.2	Normal weight	Overweight
176	SUKANYA	285472	GRADE 1	1	20	Female	36	1.52	15.6	Underweight	Underweight
177	JAYASHREE	80105	GRADE 2	1	39	Female	64	1.52	27.7	Overweight	Obese
178	CHITRA	182139	GRADE 2	1	35	Female	62	1.54	26.1	Overweight	Obese
179	ANANYA	3050862	GRADE 1	1	20	Female	35	1.51	15.4	Underweight	Underweight
180	SUNITA	323865	GRADE 1	1	24	Female	48	1.46	22.5	Normal weight	Normal weight

181	SHRAVAN	21555	GRADE 3	1	26	Male	62	1.76	20	Normal weight	Normal weight
182	NEHA	128893	GRADE 2	1	18	Female	48	1.54	20.2	Normal weight	Normal weight
183	CHANNU	202408	GRADE 2	1	18	Male	57	1.72	19.3	Normal weight	Normal weight
184	VISHAL	95684	GRADE 4	1	22	Male	48	1.74	15.9	Underweight	Underweight
185	ARJUN	185324	GRADE 4	1	24	Male	50	1.68	17.7	Underweight	Underweight
186	PRAJWAL	207135	GRADE 2	1	18	Male	46	1.7	15.9	Underweight	Underweight
187	PRADEEP	21440	GRADE 2	1	21	Male	54	1.69	18.9	Normal weight	Normal weight
188	ANKITA	310252	GRADE 1	1	27	Female	70	1.55	29.1	Overweight	Obese
189	DAYANAND	82928	GRADE 2	1	22	Male	48	1.64	17.8	Underweight	Underweight
190	ROOPLAKSHI	338755	GRADE 2	1	19	Female	56	1.58	22.4	Normal weight	Normal weight
191	SHIVASHARA	313438	GRADE 2	1	38	Male	66	1.66	24	Normal weight	Overweight
192	MAIBUB SUB.	217632	GRADE 2	1	22	Male	68	1.72	23	Normal weight	Overweight
193	TAHREEM	1236593	GRADE 2	1	23	Female	44	1.54	18.6	Normal weight	Normal weight
194	SIMRAN	385432	GRADE 2	1	19	Female	52	1.54	21.9	Normal weight	Normal weight
195	PALLAVI	185289	GRADE 2	1	26	Female	50	1.54	21.1	Normal weight	Normal weight
196	PRATHAM	231176	GRADE 2	1	20	Male	65	1.77	20.7	Normal weight	Normal weight
197	SARVAN	247107	GRADE 2	1	18	Male	74	1.83	22.1	Normal weight	Normal weight
198	SAHANA	211256	GRADE 1	1	22	Female	58	1.5	25.8	Overweight	Obese
199	NEHARIKA	165066	GRADE 2	1	22	Female	74	1.62	28.2	Overweight	Obese
200	SUDARSHAN	251156	GRADE 2	1	20	Male	54	1.7	18.7	Normal weight	Normal weight
201	NANDITA	130744	GRADE 2	1	19	Female	50	1.6	19.5	Normal weight	Normal weight
202	NIKITA	318556	GRADE 2	1	24	Female	58	1.56	23.8	Normal weight	Overweight
203	SHIVAM	190512	GRADE 2	1	28	Male	60	1.69	21	Normal weight	Normal weight
204	GANESH	257204	GRADE 2	1	18	Male	54	1.71	18.5	Normal weight	Normal weight
205	MAHIN	257879	GRADE 1	1	18	Female	65	1.57	26.4	Overweight	Obese
206	SAHANA	150695	GRADE 1	1	21	Female	52	1.55	21.6	Normal weight	Normal weight
207	USAM	200829	GRADE 2	1	20	Male	80	1.81	24.4	Normal weight	Overweight
208	MUTTAVA	211197	GRADE 3	1	24	Female	45	1.44	21.7	Normal weight	Normal weight
209	CHANDRIKA	259683	GRADE 1	1	19	Female	40	1.53	17.1	Underweight	Underweight
210	AISHWARYA	274377	GRADE 1	1	20	Female	80	1.63	30.1	Obese	Obese

211	MB HAMAD	32071	GRADE 2	1	19	Male	82	1.82	24.8	Normal weight	Overweight
212	ANAND	418634	GRADE 2	1	21	Male	50	1.63	18.8	Normal weight	Normal weight
213	NIKHIL	182378	GRADE 2	1	22	Male	68	1.42	33.7	Obese	Obese
214	SIRIN	83379	GRADE 2	1	24	Female	42	1.55	17.5	Underweight	Underweight
215	MAHADEVI	70118	GRADE 2	1	28	Female	58	1.48	26.5	Overweight	Obese
216	CHAITRA	70510	GRADE 2	1	20	Female	54	1.58	21.6	Normal weight	Normal weight
217	SAVITA	282453	GRADE 2	1	24	Female	46	1.52	19.9	Normal weight	Normal weight
218	IRFAN	31588	GRADE 3	1	27	Male	68	1.72	23	Normal weight	Overweight
219	RAJASHWARI	285289	GRADE 1	1	34	Female	58	1.6	22.7	Normal weight	Normal weight
220	ABHISHEK	285264	GRADE 2	1	18	Male	60	1.56	24.7	Normal weight	Overweight
221	KEERTI	266885	GRADE 1	1	22	Female	40	1.56	16.4	Underweight	Underweight
222	AJEET	288848	GRADE 3	1	22	Female	56	1.64	20.8	Normal weight	Normal weight
223	VEERABHADI	290617	GRADE 4	1	28	Male	38	1.56	15.6	Underweight	Underweight
224	VEERESH	23423	GRADE 2	1	25	Male	64	1.7	22.1	Normal weight	Normal weight
225	MALLIKARJUN	115324	GRADE 3	1	20	Male	74	1.7	25.6	Overweight	Obese
226	BABUGOUDA	291461	GRADE 2	1	22	Male	58	1.64	21.6	Normal weight	Normal weight
227	RUKMINI	380014	GRADE 2	1	20	Female	66	1.56	27.1	Overweight	Obese
228	AMBRISH	3000085	GRADE 2	1	25	Male	58	1.68	20.5	Normal weight	Normal weight
229	KIRANKUMAF	301185	GRADE 2	1	24	Male	79	1.63	29.7	Overweight	Obese
230	PUSHPA	49393	GRADE 2	1	32	Female	68	1.54	28.7	Overweight	Obese
231	SASHIKALA	122710	GRADE 1	1	23	Female	62	1.5	27.6	Overweight	Obese
232	BHAGYA	54054	GRADE 2	1	25	Female	74	1.61	28.5	Overweight	Obese
233	TEJASHWINI	267881	GRADE 3	1	22	Female	56	1.52	24.2	Normal weight	Overweight
234	MALLIKARJUN	127008	GRADE 1	1	24	Male	76	1.74	25.1	Overweight	Obese
235	GANESH	305619	GRADE 2	1	22	Male	70	1.58	28	Overweight	Obese
236	BHGAYASHR	163616	GRADE 2	1	24	Female	54	1.54	22.8	Normal weight	Normal weight
237	ANIL BIRADA	60111	GRADE 3	1	18	Male	65	1.69	22.8	Normal weight	Normal weight
238	SHARUBAI	131874	GRADE 2	1	36	Female	60	1.43	29.3	Overweight	Obese
239	TOHIA	78650	GRADE 2	1	20	Male	54	1.68	19.1	Normal weight	Normal weight
240	JYOTI	305851	GRADE 3	1	32	Female	48	1.65	17.6	Underweight	Underweight

241	SIDDAMMA	71734	GRADE 3	1	24	Female	46	1.5	20.4	Normal weight	Normal weight
242	SUJATA	326054	GRADE 1	1	24	Female	35	1.36	18.9	Normal weight	Normal weight
243	AKSHATA	89273	GRADE 2	1	20	Female	46	1.51	20.2	Normal weight	Normal weight
244	PRIYANKA	128098	GRADE 1	1	24	Female	50	1.5	22.2	Normal weight	Normal weight
245	PREMKUMAR	396592	GRADE 2	1	24	Male	84	1.74	27.7	Overweight	Obese
246	PRABHUGOU	92206	GRADE 1	1	20	Male	68	1.74	22.5	Normal weight	Normal weight
247	PRASHANT	150116	GRADE 3	1	28	Male	56	1.7	19.4	Normal weight	Normal weight
248	PRATIK	231575	GRADE 2	1	28	Male	60	1.67	21.5	Normal weight	Normal weight
249	AKASH	54733	GRADE 2	1	18	Male	66	1.7	22.8	Normal weight	Normal weight
250	AKSHA	153642	GRADE 4	1	19	Male	55	1.7	19	Normal weight	Normal weight
251	KENCHARAY	154248	GRADE 2	1	22	Male	54	1.75	17.6	Underweight	Underweight
252	SHANTAVEER	340502	GRADE 2	1	30	Male	82	1.76	26.5	Overweight	Obese
253	SNEHA	343906	GRADE 2	1	20	Female	46	1.52	19.9	Normal weight	Normal weight
254	JYOTI	157167	GRADE 2	1	19	Female	48	1.5	21.3	Normal weight	Normal weight
255	KARUNA	122097	GRADE 1	1	21	Female	46	1.63	17.3	Underweight	Underweight
256	ANUSHA	165752	GRADE 2	1	18	Female	64	1.72	21.6	Normal weight	Normal weight
257	PRATIBHA	125159	GRADE 2	1	23	Female	42	1.61	16.2	Underweight	Underweight
258	VAIBHAV	282033	GRADE 2	1	20	Male	68	1.74	22.5	Normal weight	Normal weight
259	ROHINI	358225	GRADE 2	1	32	Female	68	1.6	26.6	Overweight	Obese
260	AISHWARYA	127731	GRADE 2	1	29	Female	74	1.56	30.4	Obese	Obese
261	VAISHNAVI	128346	GRADE 2	1	20	Female	50	1.58	20	Normal weight	Normal weight
262	VISHAL	128353	GRADE 2	1	20	Male	46	1.64	17.1	Underweight	Underweight
263	TEJASWINI	128557	GRADE 2	1	20	Female	46	1.53	19.7	Normal weight	Normal weight
264	RENUKA	130825	GRADE 1	1	22	Female	42	1.51	18.4	Underweight	Underweight
265	ADITI	143564	GRADE 2	1	24	Female	47	1.61	18.1	Underweight	Underweight
266	VIJAYALAKSH	145170	GRADE 2	1	20	Female	38	1.55	15.8	Underweight	Underweight
267	AKSHAY	150188	GRADE 4	1	19	Male	50	1.73	16.7	Underweight	Underweight
268	SPOORTI	375838	GRADE 2	1	20	Female	48	1.45	22.8	Normal weight	Normal weight
269	BASAMMA	162407	GRADE 3	1	32	Female	46	1.49	20.7	Normal weight	Normal weight
270	RAKSHITA	182980	GRADE 2	1	18	Female	44	1.5	19.6	Normal weight	Normal weight

271	ABHIRAJ	163428	GRADE 1	1	19	Male	54	1.83	16.1	Underweight	Underweight
272	SHAHNAZ	186421	GRADE 2	1	38	Female	54	1.54	22.8	Normal weight	Normal weight
273	SANTOSH	374255	GRADE 2	1	38	Male	68	1.71	23.3	Normal weight	Overweight
274	MALLIKARJUN	167909	GRADE 1	1	18	Male	48	1.64	17.8	Underweight	Underweight
275	JYOTI	172178	GRADE 2	1	19	Female	50	1.62	19.1	Normal weight	Normal weight
276	SIDDHANT	173736	GRADE 2	1	26	Male	49	1.6	19.1	Normal weight	Normal weight
277	RITISH	203893	GRADE 2	1	22	Male	72	1.74	23.8	Normal weight	Overweight
278	RUCHITA	222482	GRADE 2	1	20	Female	36	1.44	17.4	Underweight	Underweight
279	SANJU	40066	GRADE 3	1	18	Male	55	1.75	18	Underweight	Underweight
280	RANI	388482	GRADE 2	1	29	Female	66	1.67	23.7	Normal weight	Overweight
281	AKSHATA	393231	GRADE 1	1	21	Female	45	1.53	19.2	Normal weight	Normal weight
282	PAVITRA	218230	GRADE 2	1	22	Female	46	1.54	19.4	Normal weight	Normal weight
283	POOJA	395000	GRADE 2	1	30	Female	62	1.54	26.1	Overweight	Obese
284	SHIVRAJ	219903	GRADE 2	1	20	Male	66	1.73	22.1	Normal weight	Normal weight
285	AFREEN	191773	GRADE 1	1	23	Female	42	1.54	17.7	Underweight	Underweight
286	VIDYASHREE	221870	GRADE 3	1	21	Female	35	1.57	14.2	Underweight	Underweight
287	JATTINGARAY	159645	GRADE 2	1	30	Male	62	1.77	19.8	Normal weight	Normal weight
288	RAKSHITA	33703	GRADE 1	1	20	Female	56	1.61	21.6	Normal weight	Normal weight
289	SOMASHEKA	227683	GRADE 2	1	22	Male	62	1.76	20	Normal weight	Normal weight
290	SAVITA	228061	GRADE 1	1	24	Female	56	1.68	19.8	Normal weight	Normal weight
291	CHAYA	228028	GRADE 1	1	28	Female	64	1.46	30	Obese	Obese
292	CHANDRIKA	198904	GRADE 2	1	22	Female	56	1.6	21.9	Normal weight	Normal weight
293	DIVYA	199448	GRADE 2	1	20	Female	50	1.52	21.6	Normal weight	Normal weight
294	GURUMURTH	231753	GRADE 2	1	18	Male	58	1.73	19.4	Normal weight	Normal weight
295	PAVITRA	204451	GRADE 2	1	22	Female	50	1.54	21.1	Normal weight	Normal weight
296	PALLAVI	175498	GRADE 2	1	20	Female	48	1.54	20.2	Normal weight	Normal weight
297	ANITA	952261	GRADE 2	1	24	Female	50	1.47	23.1	Normal weight	Overweight
298	GURUBASAPI	999	GRADE 2	1	34	Male	84	1.74	27.7	Overweight	Obese
299	ISHWARI	1618	GRADE 2	1	20	Female	35	1.48	16	Underweight	Underweight
300	JYOTI	280157	GRADE 2	1	35	Female	48	1.54	20.2	Normal weight	Normal weight

301	NIVEDITA	220943	GRADE 2	1	22	Female	45	1.67	16.1	Underweight	Underweight
302	SANTOSH	227232	GRADE 1	1	33	Male	68	1.64	25.3	Overweight	Obese
303	RAKSHITA	227242	GRADE 2	1	18	Female	46	1.53	19.7	Normal weight	Normal weight
304	SHRISHAIL	229756	GRADE 1	1	32	Male	72	1.64	26.8	Overweight	Obese
305	GANGUBAI	234071	GRADE 2	1	30	Female	78	1.65	28.7	Overweight	Obese
306	PRAJVAL	NA	GRADE 2	1	18	Male	59	1.79	18.4	Underweight	Underweight
307	SURESH	NA	GRADE 3	1	23	Male	56	1.73	18.7	Normal weight	Normal weight
308	DARSHAN	90940	GRADE 2	1	23	Male	60	1.5	26.7	Overweight	Obese
309	VAISHNAVI	243323	GRADE 2	1	19	Female	40	1.52	17.3	Underweight	Underweight
310	RANNAPA	15712	GRADE 3	1	19	Male	58	1.71	19.8	Normal weight	Normal weight
311	AYESHA	120672	GRADE 1	1	21	Female	43	1.48	19.6	Normal weight	Normal weight
312	RUBINA	123341	GRADE 4	1	22	Female	56	1.52	24.2	Normal weight	Overweight
313				2	18	Female	60.7	1.56	24.9	Normal weight	Overweight
314				2	21	Male	64	1.69	22.4	Normal weight	Normal weight
315				2	20	Male	65.7	1.61	25.3	Overweight	Obese
316				2	35	Male	53.6	1.71	18.3	Underweight	Underweight
317				2	31	Male	80	1.72	27	Overweight	Obese
318				2	18	Male	55.3	1.63	20.8	Normal weight	Normal weight
319				2	22	Male	58.9	1.66	21.4	Normal weight	Normal weight
320				2	20	Female	46.6	1.52	20.2	Normal weight	Normal weight
321				2	26	Male	66.2	1.67	23.7	Normal weight	Overweight
322				2	30	Female	52.6	1.68	18.6	Normal weight	Normal weight
323				2	29	Male	46.2	1.69	16.2	Underweight	Underweight
324				2	25	Female	79.4	1.64	29.5	Overweight	Obese
325				2	21	Female	42.3	1.55	17.6	Underweight	Underweight
326				2	29	Male	58.8	1.67	21.1	Normal weight	Normal weight
327				2	26	Female	71.6	1.61	27.6	Overweight	Obese
328				2	25	Male	60.2	1.7	20.8	Normal weight	Normal weight
329				2	21	Female	52.1	1.68	18.5	Normal weight	Normal weight
330				2	19	Male	87.4	1.72	29.5	Overweight	Obese

331				2	30	Female	68.9	1.59	27.3	Overweight	Obese
332				2	28	Male	44.6	1.63	16.8	Underweight	Underweight
333				2	32	Female	61.1	1.66	22.2	Normal weight	Normal weight
334				2	35	Female	50.5	1.55	21	Normal weight	Normal weight
335				2	30	Female	53.9	1.52	23.3	Normal weight	Overweight
336				2	24	Female	64.6	1.65	23.7	Normal weight	Overweight
337				2	21	Male	66.2	1.6	25.9	Overweight	Obese
338				2	31	Male	68.1	1.71	23.3	Normal weight	Overweight
339				2	22	Female	56.8	1.55	23.6	Normal weight	Overweight
340				2	18	Male	53.9	1.69	18.9	Normal weight	Normal weight
341				2	26	Female	52.1	1.55	21.7	Normal weight	Normal weight
342				2	32	Male	71.6	1.7	24.8	Normal weight	Overweight
343				2	26	Female	68.2	1.62	26	Overweight	Obese
344				2	27	Male	70.8	1.68	25.1	Overweight	Obese
345				2	35	Male	52.4	1.68	18.6	Normal weight	Normal weight
346				2	21	Female	40.4	1.52	17.5	Underweight	Underweight
347				2	27	Male	61.3	1.65	22.5	Normal weight	Normal weight
348				2	20	Female	58.7	1.64	21.8	Normal weight	Normal weight
349				2	21	Male	75.7	1.63	28.5	Overweight	Obese
350				2	19	Female	62	1.62	23.6	Normal weight	Overweight
351				2	31	Male	75.3	1.7	26.1	Overweight	Obese
352				2	24	Female	58.7	1.53	25.1	Overweight	Obese
353				2	29	Female	63.8	1.62	24.3	Normal weight	Overweight
354				2	25	Male	53.4	1.62	20.3	Normal weight	Normal weight
355				2	27	Male	68.3	1.72	23.1	Normal weight	Overweight
356				2	19	Female	65	1.68	23	Normal weight	Overweight
357				2	28	Female	61.5	1.62	23.4	Normal weight	Overweight
358				2	23	Male	58.9	1.65	21.6	Normal weight	Normal weight
359				2	33	Female	81.8	1.65	30	Obese	Obese
360				2	24	Male	53.3	1.64	19.8	Normal weight	Normal weight

361				2	21	Female	41.7	1.54	17.6	Underweight	Underweight
362				2	20	Female	70.9	1.61	27.4	Overweight	Obese
363				2	21	Male	57.7	1.74	19.1	Normal weight	Normal weight
364				2	25	Female	68.6	1.57	27.8	Overweight	Obese
365				2	20	Female	61.4	1.6	24	Normal weight	Overweight
366				2	21	Male	62.4	1.71	21.3	Normal weight	Normal weight
367				2	18	Male	54.3	1.7	18.8	Normal weight	Normal weight
368				2	23	Female	51.1	1.63	19.2	Normal weight	Normal weight
369				2	30	Male	55.6	1.61	21.4	Normal weight	Normal weight
370				2	20	Female	44.1	1.5	19.6	Normal weight	Normal weight
371				2	27	Female	45.2	1.6	17.7	Underweight	Underweight
372				2	35	Female	66.5	1.56	27.3	Overweight	Obese
373				2	19	Male	49.9	1.65	18.3	Underweight	Underweight
374				2	18	Male	64.4	1.73	21.5	Normal weight	Normal weight
375				2	23	Male	62	1.72	21	Normal weight	Normal weight
376				2	25	Female	62	1.6	24.2	Normal weight	Overweight
377				2	25	Male	60.3	1.74	19.9	Normal weight	Normal weight
378				2	19	Female	56	1.55	23.3	Normal weight	Overweight
379				2	18	Male	76.8	1.73	25.7	Overweight	Obese
380				2	27	Female	41.7	1.51	18.3	Underweight	Underweight
381				2	20	Male	58	1.69	20.3	Normal weight	Normal weight
382				2	21	Male	74	1.7	25.6	Overweight	Obese
383				2	19	Female	53.7	1.58	21.5	Normal weight	Normal weight
384				2	29	Female	56.3	1.53	24.1	Normal weight	Overweight
385				2	20	Male	69.6	1.65	25.6	Overweight	Obese
386				2	21	Male	62.8	1.73	21	Normal weight	Normal weight
387				2	35	Female	51.3	1.61	19.8	Normal weight	Normal weight
388				2	28	Male	75.5	1.64	28.1	Overweight	Obese
389				2	24	Female	58.9	1.63	22.2	Normal weight	Normal weight
390				2	19	Male	58.1	1.68	20.6	Normal weight	Normal weight

391				2	19	Female	64	1.63	24.1	Normal weight	Overweight
392				2	26	Male	49.6	1.6	19.4	Normal weight	Normal weight
393				2	31	Male	90.2	1.74	29.8	Overweight	Obese
394				2	22	Male	50.2	1.66	18.2	Underweight	Underweight
395				2	22	Female	73.1	1.56	30	Obese	Obese
396				2	19	Female	53.6	1.63	20.2	Normal weight	Normal weight
397				2	21	Female	51	1.63	19.2	Normal weight	Normal weight
398				2	31	Male	82.4	1.68	29.2	Overweight	Obese
399				2	23	Male	67	1.69	23.5	Normal weight	Overweight
400				2	28	Female	62	1.6	24.2	Normal weight	Overweight
401				2	25	Female	68.7	1.63	25.9	Overweight	Obese
402				2	30	Male	57.6	1.71	19.7	Normal weight	Normal weight
403				2	20	Female	69.6	1.62	26.5	Overweight	Obese
404				2	25	Male	62.6	1.74	20.7	Normal weight	Normal weight
405				2	28	Female	56.8	1.62	21.6	Normal weight	Normal weight
406				2	26	Female	63.9	1.62	24.3	Normal weight	Overweight
407				2	35	Female	58	1.56	23.8	Normal weight	Overweight
408				2	26	Female	54	1.61	20.8	Normal weight	Normal weight
409				2	19	Male	50.3	1.64	18.7	Normal weight	Normal weight
410				2	28	Female	55.4	1.51	24.3	Normal weight	Overweight
411				2	30	Female	57.6	1.62	21.9	Normal weight	Normal weight
412				2	18	Male	50.3	1.63	18.9	Normal weight	Normal weight
413				2	28	Female	47.6	1.51	20.9	Normal weight	Normal weight
414				2	27	Female	68.5	1.6	26.8	Overweight	Obese
415				2	27	Male	62.1	1.68	22	Normal weight	Normal weight
416				2	30	Male	50.7	1.64	18.9	Normal weight	Normal weight
417				2	32	Male	75.9	1.6	29.6	Overweight	Obese
418				2	28	Female	49.6	1.6	19.4	Normal weight	Normal weight
419				2	22	Female	48.7	1.52	21.1	Normal weight	Normal weight
420				2	23	Male	57.6	1.71	19.7	Normal weight	Normal weight

421				2	28	Female	66	1.54	27.8	Overweight	Obese
422				2	27	Male	56.1	1.69	19.6	Normal weight	Normal weight
423				2	19	Female	63	1.65	23.1	Normal weight	Overweight
424				2	20	Female	44.1	1.52	19.1	Normal weight	Normal weight
425				2	24	Female	66	1.63	24.8	Normal weight	Overweight
426				2	18	Male	53.8	1.61	20.8	Normal weight	Normal weight
427				2	34	Female	47.3	1.53	20.2	Normal weight	Normal weight
428				2	21	Female	47.4	1.59	18.7	Normal weight	Normal weight
429				2	25	Female	64	1.56	26.3	Overweight	Obese
430				2	26	Female	51	1.63	19.2	Normal weight	Normal weight
431				2	23	Female	42.5	1.51	18.6	Normal weight	Normal weight
432				2	26	Female	72.4	1.59	28.6	Overweight	Obese
433				2	20	Female	49.9	1.56	20.5	Normal weight	Normal weight
434				2	25	Male	79.6	1.68	28.2	Overweight	Obese
435				2	22	Male	83.9	1.74	27.7	Overweight	Obese
436				2	21	Female	63	1.61	24.3	Normal weight	Overweight
437				2	31	Female	43.1	1.51	18.9	Normal weight	Normal weight
438				2	18	Female	55.3	1.55	23	Normal weight	Overweight
439				2	27	Female	50.1	1.62	19.1	Normal weight	Normal weight
440				2	31	Male	65.2	1.7	22.6	Normal weight	Normal weight
441				2	33	Male	70.6	1.71	24.1	Normal weight	Overweight
442				2	30	Female	69.4	1.63	26.1	Overweight	Obese
443				2	33	Male	61.7	1.75	20.1	Normal weight	Normal weight
444				2	18	Male	66.8	1.72	22.6	Normal weight	Normal weight
445				2	32	Male	65.4	1.73	21.9	Normal weight	Normal weight
446				2	24	Female	47.5	1.61	18.3	Underweight	Underweight
447				2	30	Female	60.3	1.58	24.2	Normal weight	Overweight
448				2	26	Male	55.8	1.73	18.6	Normal weight	Normal weight
449				2	19	Female	56	1.57	22.7	Normal weight	Normal weight
450				2	19	Male	87.2	1.74	28.8	Overweight	Obese

451				2	18	Male	56.9	1.69	19.9	Normal weight	Normal weight
452				2	21	Female	59.5	1.65	21.9	Normal weight	Normal weight
453				2	29	Male	69	1.72	23.3	Normal weight	Overweight
454				2	21	Male	48.7	1.67	17.5	Underweight	Underweight
455				2	18	Female	59.9	1.57	24.3	Normal weight	Overweight
456				2	24	Female	41.2	1.52	17.8	Underweight	Underweight
457				2	29	Male	46.4	1.69	16.2	Underweight	Underweight
458				2	21	Male	52.5	1.71	18	Underweight	Underweight
459				2	29	Male	47.2	1.71	16.1	Underweight	Underweight
460				2	19	Female	54.8	1.65	20.1	Normal weight	Normal weight
461				2	32	Male	88.8	1.72	30	Obese	Obese
462				2	26	Female	49.1	1.61	18.9	Normal weight	Normal weight
463				2	26	Female	63	1.62	24	Normal weight	Overweight
464				2	20	Female	56	1.64	20.8	Normal weight	Normal weight
465				2	32	Female	42.3	1.5	18.8	Normal weight	Normal weight
466				2	28	Male	46.1	1.62	17.6	Underweight	Underweight
467				2	23	Female	59.3	1.61	22.9	Normal weight	Normal weight
468				2	18	Male	61.5	1.66	22.3	Normal weight	Normal weight
469				2	25	Female	63.6	1.53	27.2	Overweight	Obese
470				2	34	Female	49.4	1.65	18.1	Underweight	Underweight
471				2	21	Male	76.8	1.68	27.2	Overweight	Obese
472				2	29	Female	71.6	1.58	28.7	Overweight	Obese
473				2	28	Female	52.2	1.59	20.6	Normal weight	Normal weight
474				2	27	Female	57.3	1.59	22.7	Normal weight	Normal weight
475				2	20	Male	58.8	1.61	22.7	Normal weight	Normal weight
476				2	23	Male	64	1.73	21.4	Normal weight	Normal weight
477				2	31	Female	40.8	1.54	17.2	Underweight	Underweight
478				2	27	Female	51.5	1.65	18.9	Normal weight	Normal weight
479				2	26	Male	88.7	1.75	29	Overweight	Obese
480				2	33	Female	55.4	1.58	22.2	Normal weight	Normal weight

481				2	19	Male	53	1.7	18.3	Underweight	Underweight
482				2	20	Female	76.9	1.62	29.3	Overweight	Obese
483				2	19	Female	57.5	1.59	22.7	Normal weight	Normal weight
484				2	20	Female	42.7	1.63	16.1	Underweight	Underweight
485				2	19	Male	73.9	1.66	26.8	Overweight	Obese
486				2	27	Male	53.2	1.62	20.3	Normal weight	Normal weight
487				2	31	Male	80.3	1.75	26.2	Overweight	Obese
488				2	32	Female	48.7	1.57	19.8	Normal weight	Normal weight
489				2	19	Male	67.9	1.61	26.2	Overweight	Obese
490				2	24	Male	87.8	1.75	28.7	Overweight	Obese
491				2	25	Male	86.9	1.72	29.4	Overweight	Obese
492				2	31	Female	45.1	1.54	19	Normal weight	Normal weight
493				2	19	Male	59.3	1.74	19.6	Normal weight	Normal weight
494				2	32	Male	58.2	1.7	20.1	Normal weight	Normal weight
495				2	24	Female	48	1.52	20.8	Normal weight	Normal weight
496				2	22	Female	58.3	1.62	22.2	Normal weight	Normal weight
497				2	23	Female	56.2	1.58	22.5	Normal weight	Normal weight
498				2	27	Female	67	1.56	27.5	Overweight	Obese
499				2	30	Female	64	1.61	24.7	Normal weight	Overweight
500				2	20	Male	42.7	1.63	16.1	Underweight	Underweight
501				2	26	Male	55.3	1.65	20.3	Normal weight	Normal weight
502				2	18	Female	68.7	1.57	27.9	Overweight	Obese
503				2	23	Female	61.2	1.58	24.5	Normal weight	Overweight
504				2	26	Male	76.8	1.69	26.9	Overweight	Obese
505				2	30	Female	69	1.57	28	Overweight	Obese
506				2	28	Male	61.5	1.64	22.9	Normal weight	Normal weight
507				2	22	Female	52.9	1.57	21.5	Normal weight	Normal weight
508				2	30	Male	74	1.64	27.5	Overweight	Obese
509				2	24	Female	42.9	1.52	18.6	Normal weight	Normal weight
510				2	34	Male	64	1.7	22.1	Normal weight	Normal weight

511				2	31	Male	86	1.78	27.1	Overweight	Obese
512				2	18	Female	37.5	1.53	16	Underweight	Underweight
513				2	24	Male	51	1.63	19.2	Normal weight	Normal weight
514				2	19	Female	44.6	1.57	18.1	Underweight	Underweight
515				2	25	Male	55.2	1.63	20.8	Normal weight	Normal weight
516				2	31	Male	52.2	1.7	18.1	Underweight	Underweight
517				2	21	Female	46.2	1.59	18.3	Underweight	Underweight
518				2	22	Female	44.8	1.64	16.7	Underweight	Underweight
519				2	26	Female	62.4	1.62	23.8	Normal weight	Overweight
520				2	25	Female	48.5	1.53	20.7	Normal weight	Normal weight
521				2	34	Male	59	1.69	20.7	Normal weight	Normal weight
522				2	31	Female	43.2	1.61	16.7	Underweight	Underweight
523				2	18	Female	64.7	1.61	25	Overweight	Obese
524				2	21	Male	48.3	1.68	17.1	Underweight	Underweight
525				2	28	Female	49.2	1.58	19.7	Normal weight	Normal weight
526				2	24	Female	56	1.53	23.9	Normal weight	Overweight
527				2	31	Male	50.7	1.63	19.1	Normal weight	Normal weight
528				2	30	Female	57.5	1.63	21.6	Normal weight	Normal weight
529				2	22	Female	49.5	1.62	18.9	Normal weight	Normal weight
530				2	28	Male	61.7	1.68	21.9	Normal weight	Normal weight
531				2	34	Female	68	1.56	27.9	Overweight	Obese
532				2	22	Male	57.7	1.65	21.2	Normal weight	Normal weight
533				2	28	Female	69.5	1.55	28.9	Overweight	Obese
534				2	35	Female	51	1.54	21.5	Normal weight	Normal weight
535				2	23	Male	44.1	1.64	16.4	Underweight	Underweight
536				2	27	Female	49.2	1.54	20.7	Normal weight	Normal weight
537				2	21	Male	52.9	1.61	20.4	Normal weight	Normal weight
538				2	18	Female	51.9	1.75	16.9	Underweight	Underweight
539				2	29	Female	71.1	1.65	26.1	Overweight	Obese
540				2	31	Male	77	1.64	28.6	Overweight	Obese

541				2	30	Male	63.8	1.74	21.1	Normal weight	Normal weight
542				2	25	Female	56.5	1.54	23.8	Normal weight	Overweight
543				2	18	Female	49.8	1.55	20.7	Normal weight	Normal weight
544				2	23	Male	46.9	1.64	17.4	Underweight	Underweight
545				2	27	Female	45.7	1.54	19.3	Normal weight	Normal weight
546				2	27	Male	52.4	1.67	18.8	Normal weight	Normal weight
547				2	21	Male	70	1.74	23.1	Normal weight	Overweight
548				2	27	Female	60.2	1.65	22.1	Normal weight	Normal weight
549				2	30	Female	51.9	1.54	21.9	Normal weight	Normal weight
550				2	19	Female	51.4	1.59	20.3	Normal weight	Normal weight
551				2	25	Female	71.1	1.55	29.6	Overweight	Obese
552				2	26	Male	54.3	1.74	17.9	Underweight	Underweight
553				2	19	Female	58	1.52	25.1	Overweight	Obese
554				2	29	Male	65.3	1.71	22.3	Normal weight	Normal weight
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558				2	21	Female	59	1.63	22.2	Normal weight	Normal weight
559				2	25	Female	64	1.57	26	Overweight	Obese
560				2	29	Male	67.7	1.65	24.9	Normal weight	Overweight
561				2	35	Male	65.6	1.63	24.7	Normal weight	Overweight
562				2	26	Female	72.2	1.58	28.9	Overweight	Obese
563				2	21	Male	75.6	1.62	28.8	Overweight	Obese
564				2	40	Female	68	1.55	28.3	Overweight	Obese
565				2	20	Female	57.2	1.59	22.6	Normal weight	Normal weight
566				2	31	Male	49.5	1.72	16.7	Underweight	Underweight
567				2	27	Female	54.7	1.54	23.1	Normal weight	Overweight
568				2	35	Male	75.3	1.69	26.4	Overweight	Obese
569				2	41	Female	56.4	1.55	23.5	Normal weight	Overweight
570				2	31	Male	50.7	1.73	16.9	Underweight	Underweight

571				2	26	Male	78	1.74	25.8	Overweight	Obese
572				2	32	Male	74.6	1.71	25.5	Overweight	Obese
573				2	29	Female	50.5	1.6	19.7	Normal weight	Normal weight
574				2	21	Female	44	1.55	18.3	Underweight	Underweight
575				2	18	Male	58.6	1.69	20.5	Normal weight	Normal weight
576				2	22	Female	80	1.74	26.4	Overweight	Obese
577				2	24	Male	52.2	1.68	18.5	Normal weight	Normal weight
578				2	22	Male	86	1.73	28.7	Overweight	Obese
579				2	22	Female	75	1.6	29.3	Overweight	Obese
580				2	18	Male	55.9	1.62	21.3	Normal weight	Normal weight
581				2	25	Female	65.4	1.56	26.9	Overweight	Obese
582				2	22	Female	51.1	1.64	19	Normal weight	Normal weight
583				2	33	Female	63.8	1.65	23.4	Normal weight	Overweight
584				2	21	Female	67.3	1.64	25	Overweight	Obese
585				2	19	Female	47.3	1.59	18.7	Normal weight	Normal weight
586				2	19	Male	55.3	1.55	23	Normal weight	Overweight
587				2	21	Female	50.3	1.55	20.9	Normal weight	Normal weight
588				2	20	Female	53.8	1.64	20	Normal weight	Normal weight
589				2	26	Female	50.6	1.61	19.5	Normal weight	Normal weight
590				2	21	Female	40.4	1.57	16.4	Underweight	Underweight
591				2	21	Male	63.4	1.67	22.7	Normal weight	Normal weight
592				2	31	Female	51.6	1.55	21.5	Normal weight	Normal weight
593				2	21	Female	66	1.55	27.5	Overweight	Obese
594				2	24	Male	51.8	1.74	17.1	Underweight	Underweight
595				2	20	Male	74.1	1.61	28.6	Overweight	Obese
596				2	29	Male	51	1.69	17.9	Underweight	Underweight
597				2	25	Female	55.9	1.53	23.9	Normal weight	Overweight
598				2	31	Male	78	1.73	26.1	Overweight	Obese
599				2	29	Male	78	1.68	27.6	Overweight	Obese
600				2	18	Male	57	1.67	20.4	Normal weight	Normal weight

601				2	22	Female	46.7	1.56	19.2	Normal weight	Normal weight
602				2	18	Female	62.5	1.53	26.7	Overweight	Obese
603				2	38	Male	58.7	1.66	21.3	Normal weight	Normal weight
604				2	26	Male	45.2	1.66	16.4	Underweight	Underweight
605				2	18	Female	48.1	1.61	18.6	Normal weight	Normal weight
606				2	22	Female	50.6	1.53	21.6	Normal weight	Normal weight
607				2	18	Male	46.2	1.6	18	Underweight	Underweight
608				2	31	Female	45.6	1.53	19.5	Normal weight	Normal weight
609				2	18	Male	56.7	1.61	21.9	Normal weight	Normal weight
610				2	19	Male	73.5	1.73	24.6	Normal weight	Overweight
611				2	23	Female	50.8	1.6	19.8	Normal weight	Normal weight
612				2	19	Male	56	1.73	18.7	Normal weight	Normal weight
613				2	24	Female	38.6	1.53	16.5	Underweight	Underweight
614				2	19	Male	64.1	1.69	22.4	Normal weight	Normal weight
615				2	22	Female	51.8	1.62	19.7	Normal weight	Normal weight
616				2	20	Female	47.8	1.56	19.6	Normal weight	Normal weight
617				2	25	Male	76	1.73	25.4	Overweight	Obese
618				2	26	Female	55.8	1.57	22.6	Normal weight	Normal weight
619				2	27	Female	47.4	1.61	18.3	Underweight	Underweight
620				2	32	Female	64.8	1.57	26.3	Overweight	Obese
621				2	21	Male	61.1	1.67	21.9	Normal weight	Normal weight
622				2	24	Female	56.6	1.57	23	Normal weight	Overweight
623				2	18	Female	48.7	1.6	19	Normal weight	Normal weight
624				2	20	Female	57	1.64	21.2	Normal weight	Normal weight

Tvisha Prasad

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