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Correlation Between waist Circumference and Excessive Daytime Sleepiness in Adolescents Residing in Jalgaon City: A Cross-Sectional Study

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Abstract

Background: Excessive daytime sleepiness (EDS) is a growing concern among adolescents and is associated with multiple physical and psychological health outcomes. Obesity, particularly central obesity measured by waist circumference, has been linked to sleep disturbances and metabolic dysfunction. However, limited data exist regarding this association in Indian adolescent populations.

Objective: To determine the correlation between waist circumference and excessive daytime sleepiness in adolescents residing in Jalgaon city using the Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD).

Methodology: A cross-sectional study was conducted among 70 adolescents aged 12–18 years selected through simple random sampling from schools and colleges in Jalgaon. Waist circumference was measured using a standardized inch tape method. Daytime sleepiness was assessed using the modified ESS-CHAD questionnaire. Data were analyzed using Karl Pearson's correlation coefficient.

Results: Among the participants, 44.29% were males and 55.71% were females. A majority of adolescents showed excessive daytime sleepiness (55.71%). The mean ESS-CHAD score was 9.48 ± 3.14. Waist circumference was above normal limits in 58.06% of males and 56.41% of females. A strong positive correlation was found between waist circumference and ESS-CHAD scores ($r = 0.81$, $p < 0.05$), indicating that increased abdominal obesity is associated with higher levels of daytime sleepiness.

Conclusion: The study demonstrates a significant and strong positive correlation between waist circumference and excessive daytime sleepiness among adolescents. These findings highlight the importance of addressing obesity as a modifiable risk factor to improve sleep health in this population

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Introduction

Sleep is crucial for overall health and wellness.[1] It is a physiologically induced state of active unconsciousness in which the brain is largely at rest and responds mainly to internal stimuli.

The two main stages of sleep—rapid eye movement (REM) and non-rapid eye movement (NREM)—function in a cyclical pattern that is slightly predictable. There are several stages of NREM sleep, which are categorized as 1 to 3.

The relative depth of sleep is represented by each phase and stage, which provides different characteristics in terms of muscle tones, eye movement patterns, and brain waves. REM is characterized by fast eye movements, while NREM is characterized by no eye movements at all. The brief NREM stage 1 phase of sleep is followed by NREM stages 2 and 3, and ultimately REM. About 75–80% of total sleep is NREM, with the remaining 20–25% coming from REM.

During the period of the night, for different amounts of time, this sequence of events repeats itself as the progression through the stages of sleep. To finish the first cycle, it takes 70 to 100 minutes. And the rest of the cycles are 90 to 120 minutes long. As sleep start, the amount of REM in each cycle is very small, but later in the night, it can reach up to 30% of the cycle. It is routine for a night to have four or five cycles through this period.

Circadian rhythm is the body's cyclical nature for the desire for sleep. Based on light levels determined by the retina, the retinohypothalamic tract provides sensory input to the hypothalamus, which regulates it through the suprachiasmatic nucleus. A circadian rhythm lasts roughly 24.2 hours every cycle. It has also been shown that melatonin, which is generated by the pineal gland, regulates the circadian rhythm and varies in concentration depending to light intensity. At night, melatonin levels are at their highest, and throughout the day, they fall. Furthermore, the circadian rhythm has been linked to body temperature. Although everyone's temperature threshold is different, it usually means that morning temperatures will be lower and evening temperature will be greater.[2] The sleep-wake cycle is governed by an intricate circadian system, influenced by environmental cues (light, darkness) and hormonal signals (melatonin, cortisol). Circadian rhythm disturbances can be triggered by intrinsic or extrinsic factors.[1] In 2010, the American Medical Association and American Academy of Sleep Medicine jointly recognized insufficient sleep-in adolescents as a significant health concern.[3]

Sleep is becoming more widely accepted as a modifiable behavioural choice that is essential to good health and wellbeing. According to the American Academy of Sleep Medicine, individuals should sleep 7 to 9 hours every night, yet 34.8% of Americans only get 7 hours or less. Healthy sleep patterns can be influenced by environmental factors that can reduce sleep potential, such as excessive light exposure, noise from moving vehicles (air, road, and rail), temperature, and humidity. The social and environmental factors could function together to arouse people early or delay sleep activities (e.g., noisy construction, awake neighbours, street noise). Also, stress, which is linked to inadequate sleep, may adversely impact the environment. The hypothalamic-pituitary-adrenal (HPA) axis may become dysfunctional, resulting in hyperarousal or hypervigilance, decreased sleep time, and increased anxiety or mood disorders, such as depression, caused by living in an unfavourable neighbourhood or fearing crime and violence. Studies have used epidemiologic evidence to demonstrate that sleep duration, daytime sleepiness, sleep difficulties, and sleep quality are related to the physical neighbourhood environment (e.g., walkability, green space, density) and the social neighbourhood environment (e.g., social cohesion, safety, violence, disorder).[4]

Excessive daytime sleepiness (EDS) can be caused by various factors and underlying conditions. Some are poor nighttime sleep quality and quantity, circadian rhythm disorders (jet lag, shift work), underlying sleep disorders (narcolepsy, sleep apnea), medical conditions (depression, tumours, anemia) and neurological injuries (head trauma, CNS damage).Excessive daytime sleepiness is characterized by persistent sleepiness and often a general lack of energy, even during the day after apparently adequate or even prolonged nighttime sleep. Excessive daytime sleepiness is a significant issue in the US. The absence of a unified definition for excessive sleepiness in epidemiological research impedes the comparability and generalizability of study findings, compromising our understanding of its prevalence, correlates, and consequences. Epidemiological studies utilizing large general population samples have consistently shown that excessive daytime sleepiness is a common phenomenon in the United States, affecting approximately 33% of adults. 15.6% of adults experience excessive daytime sleepiness with significant daily life impairment. Excessive daytime sleepiness poses risks to personal and public safety, affecting daily activities and work performance.[5]

Questionnaires are an alternative method of diagnosing lack of sleep in this population. The Pediatric Daytime Sleepiness Scale (PDSS), one of the most used, indicates a restricted age group for adolescents. An updated version of the Epworth Sleepiness Scale, the Modified Epworth Sleepiness Scale (ESS) has more evaluation questions and a smaller age group. Even though the Cleveland Adolescent Sleepiness Questionnaire (CASQ) lacks a cutoff point for determining whether or not sleepiness is present, it is one of the most broad questionnaires to assess excessive sleepiness in that population because it asks questions about four different areas: sleepiness at school, alertness in school, sleepiness in the evening, and sleepiness during transportation. Even though it is an unusual method for measuring sleepiness, existing tools that are frequently used with children and adolescents can only be used in a few countries and in smaller populations.[6]

Several screening tools are available to identify excessive daytime sleepiness. One is the Epworth Sleepiness Scale which grades the results of a questionnaire with eight questions referring to situations encountered in daily life. The Epworth Sleepiness Scale scores range from 0-24. Score 10 or higher suggests consulting a sleep specialist. The Epworth Sleepiness Scale, introduced in 1990, is a validated instrument designed to quantify daytime sleepiness in adult populations. The Epworth Sleepiness Scale (ESS) is globally recognized and widely used for clinical and research purposes, despite some limitations. The Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD) is an official version of the Epworth Sleepiness Scale and is proposed as a valid measure of daytime sleepiness for adolescents. The Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD) is an official modification of the Epworth Sleepiness Scale, specifically designed for paediatric populations, developed by Dr Murray W. Johns. Results indicate that the ESS-CHAD functions in a similar way for adolescents to that of the ESS for adults.[7]

EDS adversely impacted School performance, which are learning challenges, low achievement, excessive absence rates, and low grades. A higher chance of domestic or auto accident, a decrease in extracurricular activities, and negative impact on physical health (prolonged low back pain, headaches, stomach pain, obesity, insulin resistance, and blood pressure dysregulation) and mental functioning (difficulties interacting with classmates or family), risk behaviors, aggressive behaviors, substance abuse, and depression or anxiety disorders). The prevalence of EDS in adolescents may be as high as 42%, which tends to be greater than the general population's prevalence of 19% to 27%.[8] Excessive daytime sleepiness is present in about 30% of very obese people, as indicated by a body mass index higher than 35 kg/m2.[9]

Obesity and sleep, however, have an inverse relationship: obesity increases the risk of sleep disorders through a variety of physiological and anatomical mechanisms, and poor sleep quality and untreated sleep disorders may lead to metabolic dysfunction and weight gain. A higher risk of cardiometabolic illnesses, including obesity, insulin resistance, type 2 diabetes, arterial hypertension, and dyslipidemia, is linked to sleep disturbances, including short sleep duration, disturbed sleep, and poor quality sleep.[10]

Obesity is the condition in which individuals carry extra body weight, primarily in the form of stored body fat. Obesity is known to negatively impact health in many ways, including the increased incidence of several major disease processes that lead to morbidity and mortality.[11] Obesity may be defined as an abnormal growth of the adipose tissue due to an enlargement of fat cell size (hypertrophic obesity) or an increase in fat cell number (hyperplastic obesity) or a combination of both.[12] Obesity can be classified into different types based on the distribution of fat in the body and its impact on health. Here are some of the types of obesity: A) Android Obesity: In this type, the fat is mainly distributed around the abdominal region, making the individual have an "apple-shaped" body. People with android obesity are at a higher risk of developing heart diseases, diabetes, and other health conditions.[13] B) Gynoid Obesity: This type is characterized by the accumulation of fat in the hips and thighs, resulting in a "pear-shaped" body. People with gynoid obesity are at lower risk for health problems compared to those with android obesity.[14] Childhood Obesity occurs during childhood and can lead to various health consequences, including breathing problems, high blood pressure, and sleep apnea.[15]

Obesity is a leading form of malnutrition. Globally, obesity is a widespread issue, it affects developed and developing nations, children and adults. Once a secondary concern, obesity now takes centre stage in public health, overtaking undernutrition as a primary focus. One of the primary determinants of ill health, obesity has far-reaching consequences. Obesity has skyrocketed worldwide, with rates more than doubling since 1980. In 2008, over 1.4 billion adults worldwide, aged 20 and above, struggled with excess weight. Of the 1.4 billion overweight adults, 35% (500 million) were obese, comprising 200 million men and 300 million women. In 2012, over 40 million children under 5 were overweight. Overweight and obesity rates are increasing in low- and middle-income countries, especially in urban areas. Developing countries account for 3 times more overweight children (30 million) than developed countries (10 million). Every year, at least 3.4 million adults die due to overweight or obesity. As overweight and obesity fuel 44% of diabetes, 23% of ischaemic heart disease, and 7-41% of certain cancers, immediate action is required. Overweight and obesity claim more lives globally than underweight. The 2007-2008 Non-Communicable Disease (NCD) Risk Factor Survey Phase 2 in India spanned across diverse states, including southern (Andhra Pradesh, Kerala, Tamil Nadu), western (Maharashtra), central (Madhya Pradesh), and northeastern (Mizoram) regions, along with Uttarakhand. The survey reveals a high prevalence of overweight individuals across most age groups, except those aged 15-24.[12]

Obesity constitutes a major public health concern, characterized by elevated morbidity and mortality rates, compromising individual well-being. Obesity is a well-established risk factor for various chronic diseases, including cardiovascular diseases (hypertension, coronary heart disease), metabolic disorders (diabetes), gastrointestinal conditions (gallbladder disease), and specific types of cancer (hormonally-related and large bowel). Obesity is associated with numerous non-fatal yet debilitating conditions, which substantially contribute to morbidity within the community. These include musculoskeletal (osteoarthritis, flat feet), vascular (varicose veins), gastrointestinal (abdominal hernia), and mental health disorders (psychological stress). Obesity increases risks during surgery and may reduce fertility. The Framingham Heart Study revealed that men more than 20% overweight are significantly more likely to experience sudden death compared to those with normal weight. Excess weight increases mortality primarily due to higher rates of hypertension and coronary heart disease.[12]

Obesity can be measured using various methods, including Body Mass Index (BMI), Waist-Hip Ratio (WHR), Waist Circumference. Obesity is marked by an abnormal distribution of body mass, where fatty tissue accumulates excessively, disrupting the balance with other body components. Obesity does not increase the body's water content. Body Mass Index (BMI), also known as Quetelet's index, is calculated by dividing an individual's weight in kilograms by the square of their height in meters. Waist circumference measurement point is midway between the lower border of the ribcage and the iliac crest (hipbone). It is a convenient and simple measurement that is unrelated to height, correlates closely with BMI and WHR and is an approximate index of intra-abdominal fat mass and total body fat. Changes in waist circumference impact cardiovascular disease and chronic disease risk. According to WHO guidelines, waist circumference thresholds associated with increased metabolic complication risk for men ≥102 cm (40 in) and Women ≥88 cm (35 in). [12]

Adolescence is defined as the developmental phase transitioning from childhood to adulthood, characterized by profound biological, psychological, and social transformations. Adolescence involves biological changes and significant social transitions, both of which have evolved over the past century. The prolonged transition from childhood to adulthood coincides with an unparalleled array of social forces, prominently featuring marketing and digital media, which profoundly impact adolescent health, wellbeing, and development. A revised, expansive definition of adolescence is crucial for framing developmentally appropriate laws, social policies, and service systems that address the complex needs of diverse youth populations.[16]

Adolescence is treated as a transition period from childhood to adulthood. During adolescence, they develop behavioural patterns and make lifestyles choices that can also affect their present health and future. According to the United Nations, approximately 18% of the global population, totalling 1.2 billion individuals, fall within the adolescent age range.[17] Globally, obesity affect 380 million children and adolescents. Low and middle-income countries bear the brunt of global health challenges. By 2030, India will account for 11% of global child obesity cases if current trends continue. India faces a triple burden of malnutrition, stunting, wasting, and micronutrient deficiencies along with an increase in childhood overweight and obesity.[18] Rising childhood obesity in developing countries will lead to increased socioeconomic burden, long-term public health challenges and escalating healthcare costs in near future. Urban areas have higher childhood obesity rates than rural areas. Adolescent overweight prevalence ranges from 10% to 30% globally.

Prevalence varies within the country due to lifestyle differences, particularly in diet and physical activity. In addition to this urbanization and industrialization are the main culprits for the increase in the prevalence of childhood obesity.[19]. Childhood often marks the beginning of obesity. Research indicates that children with obesity are three times more likely to develop obesity in adulthood compared to their peers with normal body weight, exacerbating the risk of related health complications. Childhood obesity often persists into adulthood. Tracking body weight through generations indicates that obese parents likely give birth to children who become overweight and who's offspring also often become overweight. Obesity cycles through generations. According to estimates, approximately 75% of adolescents in the United States, aged 12-18 years, report consuming fast food one or more times per week. Fast food consumption increases calorie intake and decreases diet quality, leading to weight gain in adolescents, especially those who are overweight or obese.[20]

Waist circumference (WC) provides a reliable indicator of overweight and related co-morbidities. Further, according to WC, abdominal obesity and visceral adipose tissue (VAT) are better indicators of cardiovascular risk than overweight when measured by body mass index (BMI) independently.(21) The chance of having hypertension, type 2 diabetes mellitus, hypercholesterolemia, joint discomfort, low back pain, and hyperuricemia was higher in those with a high waist circumference.(22)The aim of the study was to find correlation between waist circumference and excessive daytime sleepiness.

Need of Study

Excessive daytime sleepiness is associated with a wide range of comorbidities. It is previously studied in different population like shift workers, young adults, school going children, obstructive sleep apnea etc. but very few studies have concentrated on the relationship of daytime sleepiness and obesity in adolescent population in India.

Hence this study was undertaken to find out the correlation between daytime sleepiness and waist circumference using ESS-CHAD scale.

Aim

The aim of this study is to find out the correlation between waist circumference and daytime sleepiness in adolescents using Epworth Sleepiness scale for children and adolescents in Jalgaon city.

Objective

1. To measure the waist circumference in adolescent population in Jalgaon city.
2. To assess daytime sleepiness of adolescent using Epworth Sleepiness scale for children and adolescents.
3. To find out the correlation between waist circumference and daytime sleepiness in adolescents.

Review of Literature

Sakshi Singh, Shally Awasthi, Vishwas Kapoor, Prabhakar Mishra conducted a study in July 2023 on Childhood obesity in India: A two-decade meta-analysis of prevalence and socioeconomic correlates. This study aimed to conduct a meta-analysis to assess the prevalence of childhood obesity in India over the past two decades and identify socioeconomic factors linked to higher obesity rates in children. A meta-analysis of 21 studies (2003-2023) with 186,901 children in India was conducted to determine the pooled prevalence of childhood obesity and overweight, and to explore socio- demographic factors influencing these outcomes. Childhood obesity in India had a prevalence of 8.4%, with 12.4% classified as overweight. Male children were at higher risk, and socioeconomic factors, such as attending private schools, maternal employment, and a family history of obesity, were strongly correlated with higher obesity risk.[18]

HuiOuyang, et.al conducted a study on Circadian rhythm of daytime sleepiness in pediatric narcolepsy: A pilot study in May 2023. Excessive
daytime sleepiness (EDS) is a disabling symptom in pediatric narcolepsy, but studies on its circadian rhythms are limited. This study aimed to explore the circadian pattern of EDS in pediatric narcolepsy patients. We assessed 50 pediatric narcolepsy patients (36 males, 14 females, mean age 13.68 ± 2.75 years) using interviews and questionnaires (Children's Depression Inventory and Pediatric Quality of Life Inventory). Sleep attacks were most frequent in the morning ($p <.001$) and were correlated with classroom impairment and concerns about sleepiness (Spearman correlation:.289 to.496, $p <.05$). PedsQL and CDI scores varied significantly among morning, afternoon, and evening sleepiness groups ($p =.042$, $p =.040$). Sleepiness severity had two peaks, at 11:00 and 16:00. Treatment strategies for pediatric narcolepsy should consider circadian rhythms, and melatonin regulation may help alleviate sleepiness.[23]

Dan Zhang,et.al conducted a study on Poor sleep pattern is associated with metabolic disorder during transition from adolescence to adulthood in March
,2023. This study explored the relationship between sleep patterns and metabolic disorders in young adults. Sleep

patterns were assessed in 1,151 college students. At baseline, 729 students provided fasting blood samples and body measurements. After two years, 340 students continued providing data. Sleep patterns were categorized by chronotype, duration, insomnia, snoring, and daytime sleepiness. Metabolic scores were calculated for BMI, waist circumference, fasting blood sugar, and insulin levels. Multivariate regression analysed associations. At baseline, 4.1% had poor sleep patterns. These individuals had significantly higher metabolic scores at both baseline (1.00 ± 0.96 vs. 0.78 ± 0.72, $p < 0.05$) and at the 2-year follow-up (0.34 ± 0.65 vs. 1.50 ± 1.64, $p < 0.05$). Poor sleep patterns were linked to elevated metabolic scores at the 2-year follow-up ($\beta = 0.22$, $p = 0.001$). Poor sleep patterns contribute to increased metabolic burdens in college students, emphasizing the need to address sleep issues to reduce long-term health risks.[24]

Johanna Marie Schmickler, et.al conducted a study on Determinants of Sleep Quality: A Cross-Sectional Study in University Students in January 2023. Poor sleep quality is prevalent among university students and is linked to negative health outcomes, including reduced academic performance. This study assessed the prevalence and determinants of poor sleep quality in 1,684 German university students (mean age 22.87 ± 3.15 years). Using the Pittsburgh Sleep Quality Index (PSQI), we found that 48.7% of students reported poor sleep quality. Multiple regression analysis identified older age, being a business student, lower social status, poorer health, stress, exhaustion, and poor academic performance as significant predictors. These findings underscore the need for targeted interventions to improve sleep health, especially for business students.[25]

Diah Kurnia Mirawati, et. al conducted a study on correlating excessive daytime sleepiness with body mass index, waist circumference, and lipid profile in shift workers in October 2022. The aim of this study is to examine the relationship between excessive daytime sleepiness and body mass index, waist circumference, and lipid profile in shift workers at Dr Moewardi General Hospital, Surakarta. This cross-sectional study at Dr Moewardi Hospital, Surakarta (October 2018–July 2019), used purposive sampling. Multiple linear regression with backward elimination assessed the relationship between Epworth Sleepiness Scale scores, anthropometric measurements, and lipid profiles, with statistical significance set at $p<0.05$. Of the 150 included participants, 127 (84.67%) were women. Statistical analyses revealed odds ratios of 2.38 (95% confidence interval [CI] 1.14-4.89, p=0.000) for daytime sleepiness severity and total cholesterol levels, and 2.45 (95% CI 1.36-4.98, p=0.020) for daytime sleepiness severity and high-density lipoprotein levels. Increased total cholesterol and decreased high-density lipoprotein levels increase the risk of excessive daytime sleepiness in shift workers.[1]

Hetal M. Mistry, Ria R. Raikar conducted a study on Correlation Between Anthropometric Measures and Daytime Sleepiness in Young Adults in August, 2022.This study examined 30 young adults (18–25 years old) had their body composition and excessive daytime sleepiness (EDS) compared. The Stanford sleepiness Scale (SSS) was used to measure daytime sleepiness, and measurements of body mass index (BMI), waist-hip ratio (WHR), and neck circumference were made. SSS scores did not significantly correlate with neck circumference ($p = 0.9076$), WHR ($p = 0.8145$), or BMI ($p = 0.5876$), according to Spearman rank correlation analysis. Hence, in this group, there was no correlation between EDS and body composition metrics.[26]

Tâmile Stella Anacleto, João Guilherme Fiorani Borgio, Fernando Mazzilli Louzada conducted a study on Daytime sleepiness in elementary school students: the role of sleep quality and chronotype in Oct, 2021. This study investigated daytime sleepiness and its sleep-related factors in 363 Brazilian elementary school students (average age 12.78 ± 1.36 years) attending afternoon classes. Daytime sleepiness was measured using the pediatric daytime sleepiness scale, sleep quality with the mini-sleep questionnaire, and chronotype with the Munich chronotype questionnaire. Results showed that 52.1% of students had excessive daytime sleepiness, despite averaging over nine hours of sleep on school days and weekends. Multiple linear regression identified sleep quality, chronotype, mid-sleep time, and time in bed as significant predictors, with poor sleep quality and eveningness being stronger predictors than sleep duration. This suggests that interventions for daytime sleepiness should consider factors beyond just sleep duration.[27]

Seema S, Kusum K. Rohilla, Vasantha C. Kalyani, Prerna Babbar conducted a study on prevalence and contributing factors for adolescent obesity in present era: cross-sectional in May 2021. The primary aim of the study was to determine the prevalence of obesity among adolescents and explore its various contributing factors. A cross-sectional sampling method was used to collect data from 385 participants through standardized questionnaires and calibrated height and weight devices. Obesity categories were based on the WHO BMI scale: overweight was defined as BMI > +1 SD, and obesity as BMI > +2 SD. The study found that 6.8% of adolescents were obese, 17.1% overweight, 53.8% had a normal BMI, and 22.3% were underweight. Obesity was significantly linked to gender, socioeconomic status, diet, chocolate consumption, transportation mode, sports participation, physical activity, and screen time. Adolescents who were physically active or participated in sports had a healthier BMI, while those with more than 2 hours of screen time were more likely to be obese.[17]

Kriti D. Gandhi, Meghna P. Mansukhani, Michael H. Silber, and Bhanu Prakash Kolla conducted a study on excessive Daytime Sleepiness: A Clinical Review in May 2021. This review provides an overview of the epidemiology, diagnosis, and treatment of excessive daytime sleepiness (EDS), focusing on its causes, assessment, and current therapeutic options. Excessive daytime sleepiness (EDS) is a common condition with causes including inadequate sleep, sleep-disordered breathing, circadian rhythm disruptions, and central hypersomnolence disorders. It may also indicate underlying medical or psychiatric issues. This review covers EDS epidemiology, assessment, and treatment options, based on recent evidence and guidelines.[5]

Mahmoud Abdelaal, Carel W. le Roux, Neil G. Docherty conducted a study on morbidity and mortality associated with obesity in Mar 2017. This article summarizes obesity co-morbidities, their prevalence, and classification systems for assessing mortality risk, emphasizing tools for quantifying morbidity and the need to address obesity complications in patient management and public health. Obesity significantly contributes to morbidity, reduced quality of life, and can affect life expectancy. This article reviews key co-morbidities, their prevalence, and classification systems for assessing their impact on mortality risk. It identifies tools for quantifying morbidity and mortality risk, with cardiovascular disease and cancer posing the highest risks.[11]

Kitty C. Janssen, Sivanes Phillipson, Justen O'Connor, Murray W. Johns conducted a study on validation of the Epworth Sleepiness Scale for Children and Adolescents using Rasch analysis in January 2017. A validated measure of daytime sleepiness for adolescents is needed to better explore emerging relationships between sleepiness and the mental and physical health of adolescents. The Epworth Sleepiness Scale (ESS) is a widely used scale for daytime sleepiness in adults but contains references to alcohol and driving. The Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD) has been proposed as the official modified version of the ESS for children and adolescents. This study describes the psychometric analysis of the ESS-CHAD as a measure of daytime sleepiness for adolescents. The ESS-CHAD was completed by 297 adolescents (12–18 years) from two schools in Victoria, Australia, with exploratory factor and Rasch analyses used to assess its validity. Exploratory factor analysis and Rasch analysis indicated that ESS-CHAD has internal validity and a unidimensional structure with good model fit. Rasch analysis of four subgroups based on gender and year-level were consistent with the overall results. The results were consistent with published ESS results, which strongly indicates that the changes to the scale do not affect the scale's capacity to measure daytime sleepiness The ESS-CHAD is a reliable tool for measuring daytime sleepiness in adolescents (12–18 years). Further research is needed to confirm its validity for younger children and establish accurate cut-off points.[7]

Roberta Ferranti,et.al conducted a study on Sleep quality and duration is related with diet and obesity in young adolescent living in Sicily, Southern Italy in April, 2016.This study examined the relationship between sleep habits, Mediterranean diet adherence, and weight status in 1,586 adolescents (ages 11-14) from Sicily, Italy. Results showed that 24% were overweight or obese. An inverse correlation was found between sleep duration and BMI, fat mass, and waist circumference. Better sleep quality was linked to healthier eating, including higher fruit and vegetable intake. Shorter sleep duration and poor sleep quality were associated with higher BMI, fat mass, and unhealthy eating behaviours. These findings suggest that improving sleep could help prevent obesity in adolescents.[28]

Thiago de Souza Vilela, et.al conducted a study on Factors influencing excessive daytime sleepiness in adolescents in May 2015. This study aimed to assess the prevalence of excessive sleepiness and identify factors associated with sleep deprivation in adolescents. A cross-sectional study of 531 adolescents (ages 10-18) from two private and one public school, using five questionnaires and statistical analyses including linear correlation and logistic regression.39% of adolescents experienced sleep deprivation, with higher deficits in private school students ($p < 0.001$). Age and sleep hyperhidrosis were significant risk factors ($p < 0.001$ and $p = 0.02$, respectively). Sleep deprivation is prevalent, especially among private school students. Older age and sleep disorders like hyperhidrosis increase the risk.[6]

Judith Owens conducted a study on insufficient sleep in Adolescents and Young Adults: An Update on Causes and Consequence in September 2014. This report aims to review adolescent sleep patterns, factors contributing to chronic sleep loss, and related health consequences, while exploring the potential benefits of later school start times to reduce sleepiness and improve health. Chronic sleep deprivation in adolescents poses significant risks to academic performance, health, and safety, making it a critical public health issue. This report reviews literature on adolescent sleep patterns, identifies contributors to sleep loss (such as electronic media use and caffeine), and examines associated health risks like depression, obesity, and drowsy driving. It also explores the potential benefits of later school start times to reduce sleepiness and improve adolescent health.[3]

M Shashidhar Kotian, Ganesh Kumar S1, Suphala S Kotian conducted a study on Prevalence and Determinants of Overweight and Obesity Among Adolescent School Children of South Karnataka in India in February 2010. Childhood obesity is a growing public health issue in urban areas of developing countries. This study examines the prevalence and determinants of overweight and obesity among adolescents in South Karnataka. A cross- sectional study conducted from January to April 2007 with 1,000 adolescents (ages 12-15) from six Mangalore schools, collecting data on physical activity, screen time, and dietary habits. Overweight and obesity were defined using International Obesity Task Force criteria. Out of 900 adolescents, 9.9% were overweight and 4.8% were obese. Girls had a slightly higher prevalence of overweight (10.5%) than boys (9.3%), while obesity rates were 5.2% in boys and 4.3% in girls. Key risk factors included higher socioeconomic status, low physical activity, excessive screen time, and daily chocolate consumption.[19]

Mercedes de Onis, et.al conducted a study on Development of a WHO growth reference for school-aged children and adolescents in September 2007. This study developed growth curves for school-aged children and adolescents, aligning with the WHO Child Growth Standards for preschool children and adult BMI cut-offs. Data from the 1977 NCHS/WHO growth reference (ages 1–24) and the under-fives growth standards (ages 18–71 months) were combined using the Box-Cox power exponential (BCPE) method. The merged datasets ensured a smooth transition at age 5 for height, weight, and BMI-for- age, with minimal differences (0.0–0.1 kg/m^2). At age 19, BMI values at +1 SD were 25.4 kg/m^2 for boys and 25.0 kg/m^2 for girls, matching adult overweight cut-offs. The +2 SD value (29.7 kg/m^2) aligns with the adult obesity cut-off. These new curves bridge the gap in growth references for ages 5–19.[29]

Methodology

Materials and methods

Study Design: A Cross-sectional study

Sampling method: simple random sampling

Sample Size: 70 (Karl Pearson's correlation test and calculation were done on data on similar study)

Study Duration: 6 months
Study Settings: Schools and Colleges in and around Jalgaon.
Study Population: Adolescents.

Materials
1. Inch tape
2. Pen
3. Paper
4. ESS-CHAD scale

Inclusion Criteria
1. Individual from Age group of 12 to 18.
2. Both genders male and female.
3. Individual who are willing to participate in the study.
4. Individuals who are sleeping for at least 6-7 hours daily in the night.

Individuals who are not involved in any type of exercise for at least 3 days in a week since last 3 months.

Exclusion Criteria
1. Individuals with known case of musculoskeletal / cardiovascular / respiratory / neurological diseases and/ or disorders.
2. Individuals suffering from psychological diseases/disorders.
3. Individuals who have been already diagnosed with Sleep diseases/disorders.
4. Individuals who are on medications which affect sleep.

Outcome Measures
Waist Circumference:
Measurement of the waist circumference was taken by placing the measuring tape at the top of hip bone, then bring it all the way around body and then leveling it with belly button. It was ensured that it was not too tight and was straight, even at the back. Participants were asked not to hold breath or pull in belly while measuring. The number on the tape was measured right after the exhale.

Modified ESS-CHAD questionnaire:
Assessment of daytime sleepiness was done by modified ESS-CHAD questionnaire. The participants were given with the questionnaire and they were asked to answer the questions in the questionnaire. Individual rated the likelihood of falling asleep while engaging in each of the 8 activities listed over the past month using a 4-point scale such as 0- would never fall asleep; 1- slight chance of falling asleep; 2- moderate chance of falling asleep; and 3- high chance of falling asleep. All activities are weighted equally and scored as 0, 1, 2, or 3, and then summed. The total ESS-CHAD score ranges from 0 to 24, with higher scores representing greater daytime sleepiness as perceived by individual.

Procedure
Ethical clearance was taken from the Institutional Ethics Committee of DR ULHAS PATIL COLLEGE OF PHYSIOTHERAPY, JALGAON prior to the commencement of study.

A cross-sectional study was carried out to find out the correlation between waist circumference and daytime sleepiness in adolescents. Participants were selected based on the inclusion and exclusion criteria.

First, the nature and purpose of study had been explained to the participants.

A written consent had been taken from the participants.

The participants had been given with ESS-CHAD questionnaire to know their daytime sleepiness and then their waist circumference is noted.

The data was collected, analysed and results has been generated.

Statistical analysis
- The data and tests result of subjects was entered in MS Excel sheet before it was statistically analyzed.
- The statistical analysis was done for a waist circumference and modified ESS-CHAD questionnaire
- All the results are shown in tabular as well as graphical format to visualize the statistically difference more clearly.
- Quantitative analysis was done by using MS excel.

Results

The study was aimed at finding correlation between waist circumference and daytime sleepiness in adolescents using Modified Epworth Sleepiness Scale for Children and Adolescents. There were 70 participants included in the study. The waist circumference was measured in adolescent population residing in Jalgaon and daytime sleepiness was assessed by using modified ESS-CHAD scale. The results were obtained by Karl Pearson's correlation test for Correlation between waist circumference and daytime sleepiness.

Table 1: gender wise distribution of male and female

Variable	Groups	Frequency	Percentage %
Gender	Male	31	44.29%
	Female	39	55.71%

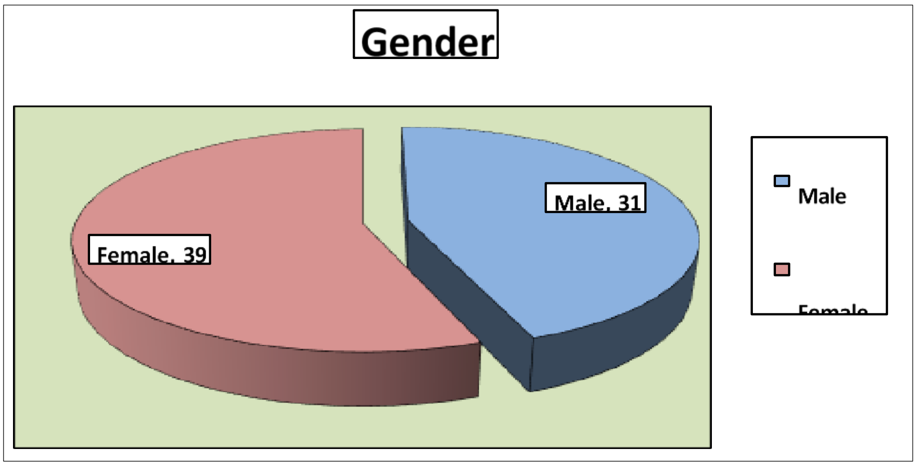

Fig 1:

Table no.1 and the graph no.1 show the gender distribution of a 70 participants. There are 70 participants in total, 31 (44.29%) of which are men and 39 (55.71%) of that are women. It shows that the number of female participants were slightly more than the number of male participants.

Table 2: Waistcircumference In Male and Female

Variable	Gender	Groups	Frequency	Percentage%	Mean ± SD
Waist Circumference	Male	below 102 cm	13	41.94%	92.86 ± 14.92
		above 102 cm	18	58.06%	
	Female	below 88 cm	17	43.59%	
		Above 88 cm	22	56.41%	82.01 ± 13.58

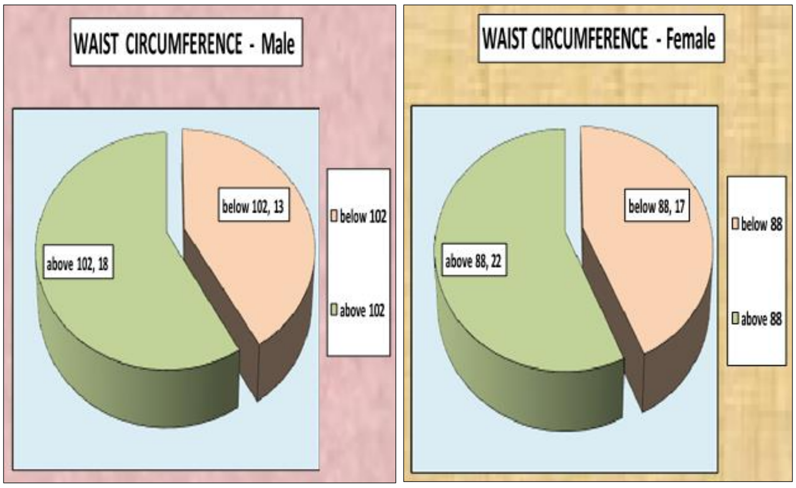

Fig 2:

Table no.2 and graph no.2 show the waist circumference data for men and women. Thirteen people (41.94%) in the male population have a waist circumference below 102, and only eighteen people (58.06%) have a circumference above 102. Mean and standard deviation (SD) of waist circumference for 31 males is 92.86 ± 14.92. In females, 22 individuals (56.41%) have a waist circumference above 88, whereas 17 individuals (43.59%) have a waist circumference below 88. Mean and standard deviation of waist circumference for females is 82.01 ±13.58.

Table 3: Modified Ess-Chad Score In Adolescents

Variable	Groups		Frequency	Percentage%	Mean ± SD
Modified Ess-Chad Score	Below 10	Normal	31	44.29%	9.48 ± 3.14
	> 10	Excessive Sleepiness	39	55.71%	
	> 16	High level Sleepiness	0	0.00%	

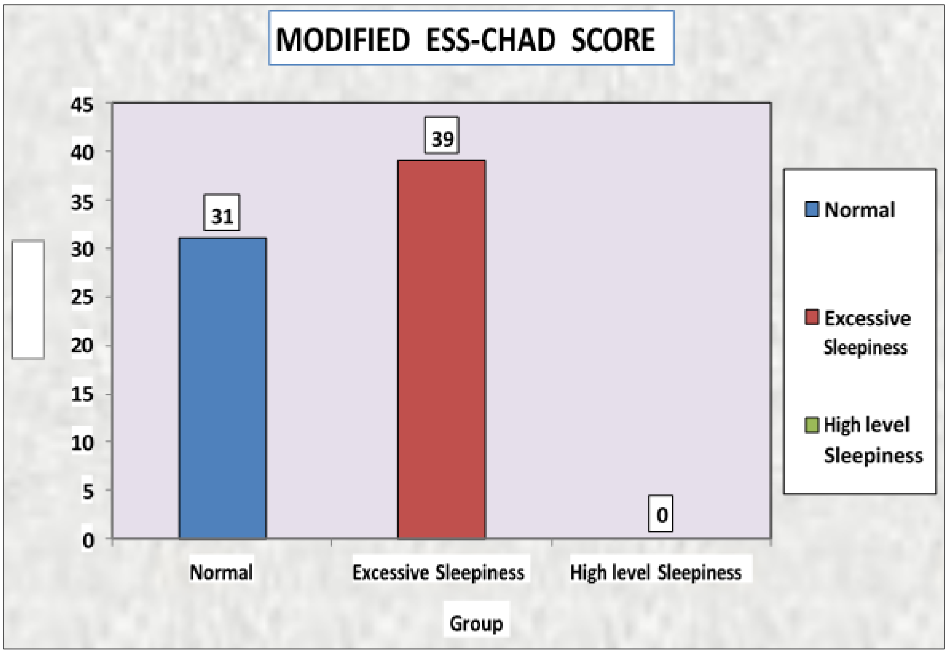

Fig 4:

Table no.3 and graph no.3 are show the data of excessive daytime sleepiness which was obtained by scores of adolescents Modified ESS-CHAD questionnaire. Based on their scores, adolescents are classified into three groups according to the Modified ESS-CHAD score: Normal daytime sleepiness (below 10), Excessive Sleepiness (>10), and High-level Sleepiness (>16), as seen in the table. There are 31 (44.29%) adolescents who have Normal daytime sleepiness,
39 have (55.71%) Excessive daytime sleepiness, and 0 in the High-level Sleepiness group. The mean and SD of Modified ESS-CHAD score is 9.48 ± 3.14.

Table 4: Correlation Between Waist Circumference(Cm) And Modified Ess-Chad Score

Correlation coefficient	p value
0.81	0.00

*p value less than 0.05, shows the significant correlation Graph No.4

The graph no. 4 shows a correlation analysis using Karl Pearson's correlation test between the Modified ESS-CHAD score and waist circumference (in cm). The graph no. 4 shows Modified ESS-CHAD score on the y-axis and waist circumference on the x-axis. The correlation coefficient obtained was 0.81 with p-value 0.00. A correlation coefficient of 0.81 which is ranging towards 1.00 indicates strong correlation between waist circumference and Modified ESS- CHAD score. As there is increase in waist circumferences, there is rise in modified ESS CHAD score indicating strong correlation.

Discussion

The present research was conducted on 70 subjects and correlation was assessed between waist circumference and daytime sleepiness using ESS-CHAD scale. The results found in our study showed a positive and strong correlation between both the variables i.e. waist circumference and daytime sleepiness using ESS- CHAD scale.
The results obtained in our study are similar with the study done by Amie C. Hayley, Lana J. Williams, Gerard A. Kennedy, Michael Berk, Sharon L. Brennan, Julie A. Pasco. They conducted research on Excessive Daytime Sleepiness and Body Composition and found that EDS was associated with greater waist circumference and body mass index (BMI). In women, EDS was associated with greater total waist circumference [having mean 93.6 (91.2–96.1) vs. 91.0 (89.5–
92.6) cm, p=0.03] and BMI [Mean 30.0 (29.0–31.1) vs. 29.1 (28.4–29.7) kg/m2,
p=0.07]. Compared to women of normal weight, having EDS was also associated with 1.5-fold increased odds of being

overweight (adjusted OR=1.5, 95%CI 1.0– 2.3, p=0.04), and 1.6-fold increased odds of being obese (adjusted OR=1.6, 95%CI 1.1–2.3, p=0.02). In men, EDS was associated with greater BMI [Mean 28.6 (27.5–29.7) vs. 27.2 (26.9–28.6) kg/m2, p=0.03].[30]

The results found in our study are in contrast with the results found in a study done by Hetal M. Mistry1, Ria R. Raikar2. They conducted research on Correlation Between Anthropometric Measures and Daytime Sleepiness in Young Adults. The study evaluated 30 young Indian adults (mean age: 20.90 ± 0.316 years; 21 females, 9 males) and their anthropometric measurements (Body Mass Index, Waist Hip Ratio, and Neck Circumference) in connection to their daily sleepiness (Stanford Sleepiness Scale). 10 were obese, 2 were underweight, 16 were normal, and 2 were overweight. The participants' mean BMI was 22.67 ± 0.62. NC was normal in 14 and up in 16 (mean: 32.85 ± 0.7930), but WHR was normal in 25 and up in 5 (mean: 0.7640 ± 0.0145). SSS scores were between 1 and 6, with the majority (n=27) receiving a score of ≤4 (mean: 2.60 ± 0.218). There was no significant link between SSS and NC (p = 0.9076), WHR (p = 0.8145), or BMI (p = 0.5876) according to Spearman's correlation. Results show that there is no significant connection between the group's anthropometric measurements and daytime sleepiness.

Obesity has long been thought to impact sleeping patterns by impairing a number of physiological processes. Sleep duration had an indirect relationship with obesity.[26] About five percent of adults suffer from daytime sleepiness, and its incidence seems to be rising. While likely general underlying causes of daytime sleepiness, such as sleep disorder and sleep loss, have received the proper attention, the possible contribution of obesity as a common illness has been underestimated. Our research offers strong corelation between obesity and daytime sleepiness. The underlying mechanisms of daytime sleepiness associated with obesity are not clear.

Previous studies have mentioned that daytime sleepiness and nighttime disturbance are manifestations of a circadian and metabolic abnormality that is associated with hyperarousal during the night and hypo arousal during the day. Obese patients have a higher sleep propensity (sleep latency) during the day but it is more difficult for them to fall asleep at night. Also, it was found in previous studies that the presence of lower amounts of (rapid eye movement) sleep during the early part of the night in contrast to the higher amounts of REM sleep during the early morning hours in obese patients suggests a possible circadian shift of REM sleep. All these factors combined lead us to hypothesize that daytime sleepiness in obese patients appears to be primarily a manifestation of a circadian and metabolic abnormality of obesity.

Another proposed mechanism of daytime sleepiness in obese are linked to inflammatory cytokines (tumour necrosis factor alpha [TNF-alpha] and interleukin 6[IL-6]. The plasma levels of inflammatory cytokines (tumour necrosis factor alpha [TNF-alpha] and interleukin 6[IL-6] have been found elevated in disorders of excessive daytime sleepiness. Also, literature related to obesity have shown that TNF- alpha and IL-6 levels were highest in the obese patients and there was a strong correlation between BMI and IL-6 levels.[31]

So, significant correlation (r = 0.81, p = 0.00) between waist circumference and excessive daytime sleepiness using Modified Epworth Sleepiness Scale obtained in this study is justified as per above mechanism.

Conclusion

From this study we can conclude that there is strong correlation between waist circumference and daytime sleepiness using modified ESS-CHAD scale.

Future Scope

Larger sample sizes across different regions of India can improve generalizability.

- Exploring hormonal and biochemical markers (like melatonin, cortisol, inflammatory cytokines) may clarify underlying mechanisms.

Limitation

- The data was collected from small population of adolescent from particular region in the Jalgaon and hence, the extensive application of the results to a wider population needs to be interpreted.

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