Original Article

The Impact of Obesity on Deep Neck Flexor Endurance among College Students in Chennai: A Cross-Sectional Study

[1]Malavika Dhanaraman, [2]Loganathan Devaraj, [3]M. Saravana Hari Ganesh

[1]Assistant Professor, College of Physiotherapy, Faculty of Medical and Health Sciences, Trichy SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology (SRMIST), Irungalur, Tiruchirappalli,, Tamil Nadu, India, [2]Research Scientist I, Department of Preventive and Social Medicine, Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER), Puducherry, India, [3]Professor, SRM College of Physiotherapy, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, 603203, India

How to cite this article: Malavika Dhanaraman, Loganathan Devaraj, M. Saravana Hari Ganesh. The Impact of Obesity on Deep Neck Flexor Endurance among College Students in Chennai: A Cross-Sectional Study. Indian Journal of Physiotherapy and Occupational Therapy / Vol 20 No. 2, April - June 2026

Abstract

Background: Obesity is an epidemic that impacts individuals across all age groups, from children and adolescents to adults and the elderly. The purpose of this study is to assess the relationship betweenobesity and deep neck flexor endurance a mong college students.

Methodology: A cross-sectional study was conducted on obese college students without neck pain. The measure of obesity used was the Asian Body Mass Index (BMI) classification, and muscular endurance was assessed using the Deep Neck Flexor Endurance Test (DNFET). Relationships were explored through Pearson's correlation coefficient (r) analysis.

Results: A total of 100 (60 male, 40 female) obese college students were enrolled. These college students had a significantly reduced DNFE. The correlationr value for males and femaleswas-0.822 and -0.762**,** so there is strong negative correlation.
Conclusion: Obese college students exhibit a lack of deep neck muscle endurance, which may increase the risk of developing neck muscle injuries.

Keywords: Deep Neck Flexor Endurance, Obesity, collegiate students, BMI, DNFE hold time.

Introduction

Obesity is a root cause of major health issues in modern society and has become an epidemic disease due to the lack of conscientious health habits and lifestyle modifications. Nowadays, with an increase in computer-related work and prolonged working hours, an inactive lifestyle has led to consequences such as altered eating, insufficient sleep, lack of exercise, and changes in physical activity patterns. Obesity is a state in which excessive deposition of body fat occurs when there is a decrease in energy

Corresponding Author: M.Saravana Hari Ganesh, SRM College of Physiotherapy, Faculty of Medicine and Health Sciences, SRM Institute of Science and Technology, Kattankulathur, Chengalpattu, Tamil Nadu, 603203, India

E-mail: saravanm@srmist.edu.in

Submission: Sep 5, 2025 **Revision:** October 27, 2025 **Published date:** April 3 , 2026

expenditure compared to the amount of food intake. This results in an increase in calorie storage and stimulates the consumption of unhealthy, high-calorie foods[1].

The World Health Organization (WHO) reported in 2021 that the global prevalence of obesity has nearly tripled since 1975. More than 1.9 billion adults worldwide are overweight, and over 650 million of them are classified as obese[2]. Obesity is now recognized as a major public health concern with serious consequences for both individuals and society[3]. It is a well-established risk factor for several non-communicable diseases, including cardiovascular disease, diabetes, musculoskeletal disorders, and various cancers[4,5]. In addition, increasing levels of obesity have been linked to reduced physical fitness, particularly in domains such as muscular endurance, strength, and flexibility, which may contribute to a higher risk of head, neck, and whiplash-related injuries[6–9].

Excess body weight also places mechanical strain on the musculoskeletal system, commonly leading to discomfort in the neck, lower back, and knees[10,11]. Weakness in the neck flexor muscles has been associated with reduced strength and endurance, muscle atrophy, fatty infiltration, and abnormal activation patterns, all of which can compromise cervical stability and increase the likelihood of musculoskeletal problems[12]. Muscular endurance is defined as the ability of a muscle group to sustain repeated contractions or maintain a position over time. In the cervical region, the deep neck flexor muscles are essential for stabilizing the head and cervical spine against gravity. Reduced endurance of these muscles can result in cervical deformities, postural imbalances, and functional limitations. The DNFET is a reliable, simple, and non-invasive method for evaluating the endurance of these muscles and their contribution to cervical spine stability[13–18].

With obesity becoming increasingly common among young adults, particularly college students, it is important to understand its impact on neck flexor endurance. Previous studies in India have estimated the prevalence of obesity in this group at approximately 10.7%, a trend often linked to sedentary behavior, low physical activity, and academic pressures[19]. The present study examines the relationship between obesity and deep neck flexor endurance in college students and determines the average DNFE hold times in this population.

Materials and Methods

Study Design

A cross-sectional study

Study Setting

The study was conducted at SRM Institute of Science and Technology (SRMIST), Chennai, Tamil Nadu, a multidisciplinary university offering programs in engineering, medicine, health sciences, management, and humanities.

Participants

College students aged 18–25 years with a Body Mass Index (BMI) greater than 25, as per the Asian BMI classification, were included. Participants were required to be free of current neck pain and able to lie in the supine position for at least 30 minutes. Exclusion criteria included a recent history of neck or thoracic pain, cervical fractures, frequent headaches, regular gym training, diagnosed myopathies, cervical spine deformities, neurological conditions, or any muscular or connective tissue disorders. All criteria were based on self-reported medical history. A purposive sampling method was used to recruit eligible participants.

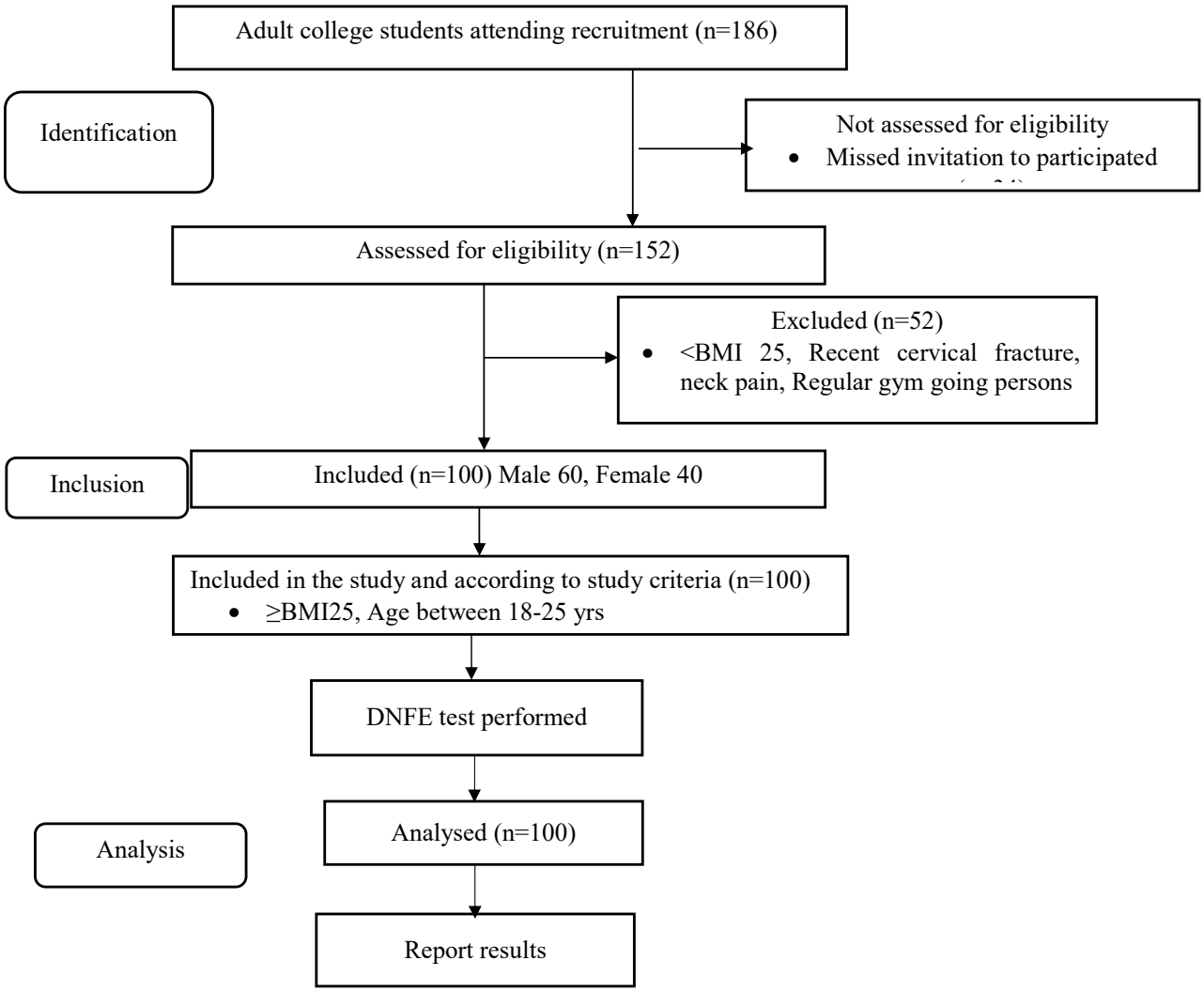
Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of SRM College of Physiotherapy, Chennai (Approval No. IEC.0050). Written informed consent was collected from all participants before enrolment.

Dnfet Procedure

The DNFET is the most widely utilised clinical test for assessing the endurance of the deep neck

flexors[20,21]. Based on the eligibility, 100 asymptomatic college students were included in the study (refer flowchart 1). The participants lay on their backs in a hook lying position (head straight, knees bent, and both feet resting on the couch), with their hands placed on their abdomen region. Individuals who experienced difficulty lying flat on the couch due to excess kyphosis were provided with a conventional sandbag to comfortably support their head and neck. Subjects were instructed to tuck their chin in as much as possible in an isometric stance and were asked to maintain the position for as long as they could. They were then told to lift their head and neck approximately 2.5 cm off the couch while keeping the chin tucked. The analyst maintained the width by stacking his index and middle fingers, kept in contact with the subject's head in the back part of the occipital. Simultaneously, in this position, the analyst drew a line up to 1 cm across two approximated horizontal skin folds along the subject's anterior-lateral side of the neck with an erasable marker[21], as shown in figures 1 and 2.



A flowchart 1showing the steps involved in this study.

Figure 1

Figure 1: The tester places their hand palm down beneath the subject's occiput and crosses their index finger across their middle finger dorsally. The subject's anterior-lateral neck is shown by the arrow by a line drawn across two approximation skin folds.

Figure 2

Figure 2: A supine, hook-lying position was used to perform the DNF endurance test for this study.

During the DNFET, subjects were requested to follow commands from the examiner, such as "Lift your head and pull your chin maximally." They were instructed to keep their heads in direct contact with the examiner's fingers at all times. Subjects were permitted to maintain touch with the analyst's fingers without putting any weight on their heads by lifting the head and maintaining the tucked chin posture. A stopwatch was used to measure the time of holding in that position. Subjects were required to remain supine for the entire experiment. After the evaluation, subjects were given five minutes of free time to relax. During this rest time, they were told not to raise their heads or get out of bed, but they were permitted to gently rotate their neck as long as there was no discomfort[20].

The subjects were asked to maintain the position as much as they could, and a stopwatch was used to measure the time of holding in that position. Subjects were tested twice with a 5-minute break between the tests to allow muscle recovery. Two scores were recorded, and the best one was used for statistical analysis. To account for the high experience curve linked with the DNFET, the measurement was only carried out twice. Each time, the maximal attained time was noted. Time recording for each trial started, and if a mistake occurred during the trial time, the individual's posture was rectified by verbal commands. The countdown on the stopwatch commenced as soon as the individuals elevated their heads and ceased if any one of the following four criteria ruled out and lasted longer than one second.

While performing the DNFET, it was observed that there is a possibility of one error lasting longer than one second out of the following four scenarios:(1).The moment when the subject's chin could no longer be tucked in, and the vertical cross line in the skin fold disappears, not in contact with the neck line due to the loss of chin tuck.(2).When the evaluator's stacked finger perceives the weight of the subject's head rested on it for more than 1 second. (3).When the subjects lifted their head without holding, the evaluator observed that they were unable to maintain contact with the crossed finger. (4).When the subjects were unwilling to continue the procedure.The subject was given verbal guidance by the assessor at the time of the error on how to fix it. The measurer stops the measurement and records the timings if an error happens twice[22].

Statistical Analysis

Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) software, version 23. Based on normality,Pearson's correlation method was employed to assess the association between obesity, measured by BMI and DNF Endurance among college students, with a significance level set at $P < 0.05$.Additionally, a simple linear regression analysis was conducted to further explore the relationship between BMI and DNF Endurance. The findings from both correlation and regression analyses contribute to a comprehensive understanding of the potential impact of BMI on DNF Endurance.

Results

A total of 100 participants (male-60, female-40) were included in this study. Table 2 shows the mean and standard deviation value of age,height, weight,BMI are 19.79±1.73 years, 168.27±8.93(cm), 80.63±11.58(kg) and28.5±3.5 kg/m^2.

Table 2. Sociodemographic characteristics of persons with obesity among collegiate students in Chennai, (N=100).

Variables	n	Age (y)*	Weight (kg)*	Height (cm)*	BMI (kg/m^2)*
Entire sample	100	19.79±1.73	80.63±11.58	168.27±8.93	28.5±3.5
Male	60	19.42±1.86	86.68±10.31	173.28±6.94	28.99±4.02
Female	40	20.35±1.33	71.55±6.23	160.75±5.75	27.76±2.24

n = number of subjects per group; y = year; cm = centimetre; kg=kilogram; BMI= body mass index; * Mean ± standard deviation.

Table 3 demonstrates a significant negative correlation between BMI and DNFE in the entire sample. A Pearson correlation analysis revealed a noteworthy negative association between BMI and DNF endurance in the entire sample ($r = -0.440$, $p < 0.001$). Among male participants, the correlation was even more pronounced ($r = -0.822$, $p < 0.001$), signifying a stronger negative relationship between BMI and DNF endurance. Similarly, for female participants, the correlation was significant ($r = -0.762$, $p < 0.001$), indicating that higher BMI is associated with reduced DNF endurance in both genders. Figure 3 shows the negative relationship between BMI and DNF endurance.

Table 3. Relationship between BMI and deep neck flexor endurance in persons with obesity among collegiate students in Chennai, (N=100).

Variable	n	Mean±SD		r	Beta Coefficient	SE	*p* value
		BMI (kg/m^2)	DNFE (s)				
Entire sample	100	28.5±3.5	20±3.1	-0.440	-0.396	0.082	<0.001
Male	60	30±4	21.9±2.5	-0.822	-0.505	0.046	<0.001
Female	40	27.8±2.2	17.4±1.8	-0.762	-0.610	0.084	<0.001

$p < 0.05$; SD- standard deviation; BMI- body mass index; DNFE-deep neck flexor endurance; s-seconds; r- pearson correlation coefficient; SE- standard error;

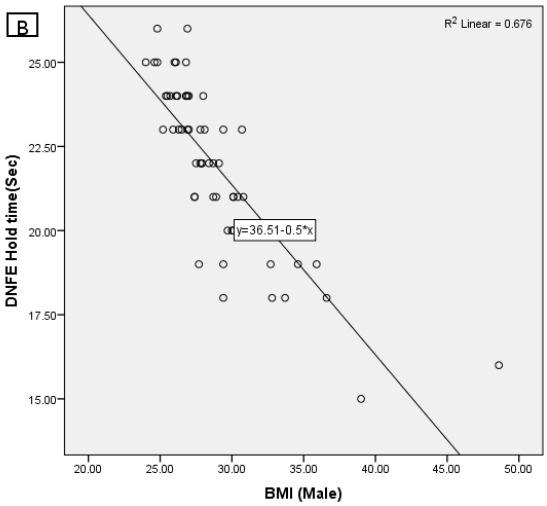


Figure 3.A

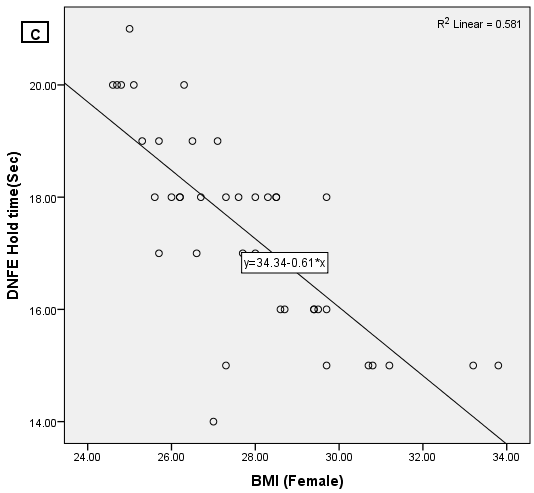


Figure 3.B

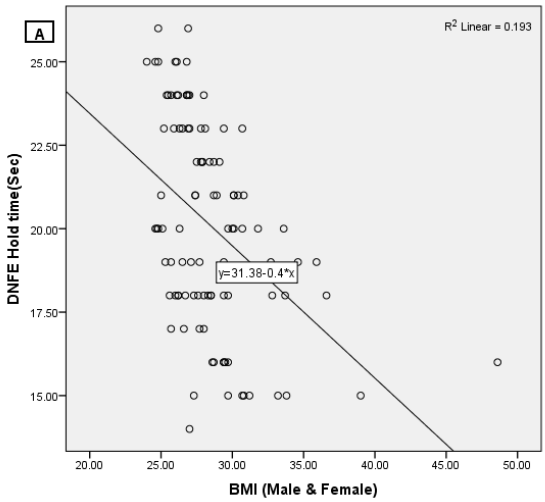


Figure 3.C

Figure 3: The scatterplots (Figure3.A, 3.B, and 3.C) visually depict the relationship between BMI and DNF endurance across the entire sample, male and female participants, respectively.

The regression analysis indicated a significant negative association between BMI and deep neck flexor (DNF) endurance. Overall, BMI was a significant predictor of DNF endurance, with a negative beta coefficient (β = –0.396, SE = 0.082, p <.001), suggesting that for every one-unit increase in BMI, DNF endurance decreased by approximately 0.40 seconds on average.When analysed by sex, BMI remained a significant negative predictor of DNF endurance. Among males, the regression model showed a beta coefficient of β = –0.822 (SE = 0.505, p <.001), indicating that each one-unit increase in BMI was associated with a reduction of 0.82 seconds in DNF endurance. Similarly, for females, the beta coefficient was β = –0.762 (SE = 0.610, p <.001), reflecting an average decrease of 0.76 seconds in DNF endurance for every unit increase in BMI.

Discussion

This study was conducted to evaluate the relationship between obesity and DNFE in college students and to establish the average hold times on the DNFET in this population. The endurance of the cervical flexor muscles plays a key role in maintaining

cervical spine stability, and any reduction in their function may disrupt the balance between the anterior and posterior stabilizing muscles of the neck. The DNFET is a simple, reliable, and cost-effective clinical test for assessing craniocervical flexor performance and is valuable in both the prevention and management of neck pain. The results of this study indicate that obesity is significantly associated with reduced deep neck flexor endurance among college students.

The present study found that obese college students demonstrated markedly lower DNFE compared to values reported in earlier research on healthy populations[20,21]. The mean DNFE hold time was 21.9 seconds in males and 17.4 seconds in females. A statistically significant negative correlation (r = –0.440) was observed between BMI and DNFE in both sexes, indicating that higher BMI is associated with reduced endurance capacity of the deep neck flexors.These findings align with previous evidence suggesting that obesity adversely affects musculoskeletal performance. Oliveira et al.[23] and Watson et al.[24] reported that poor biomechanical adaptation in posture and physical performance contributes to the development of neck pain in obese individuals. Similarly, Jarman et al.[20] demonstrated that higher fat composition and BMI are linked to diminished muscular endurance in the back and core, further supporting the inverse association between BMI and DNFE identified in the current study.

When compared with endurance values in non-obese populations, the reduced hold times in the present study are evident. Domenech et al.[25] reported DNFE hold times of 39.1 ± 20.0 seconds in males and 29.3 seconds in females among healthy adults aged 20–80 years, while Jarman et al. found hold times of 35.5 seconds in males and 31.8 seconds in females among adolescents and young adults. These values are considerably higher than those observed in our obese college cohort. Furthermore, Zele et al.[26] reported decreased neck flexor and extensor endurance in cigarette-smoking students, highlighting the influence of lifestyle-related factors on cervical muscle function.Taken together, the present study extends prior findings by specifically examining the impact of obesity on DNFE in college students, confirming that higher BMI is associated with significantly reduced neck muscle endurance.

When correlating obesity and DNFE separately for male and female students, there is a strong negative correlation. However, when correlating obesity and DNFE for overall subjects without gender differences, there is a moderate negative correlation, possibly due to shorter hold times for females. The study underscores the negative association between Deep Neck Flexor Endurance and obesity among college students, suggesting that females with higher BMI may be more prone to neck pain compared to males with similar BMI.Clinical implications include regular assessment of DNFE in patients with neck pain to identify reduced neck flexor endurance. If endurance is found to be low, endurance training can be incorporated along with conventional physiotherapy. Collins et al.,[27] and Kim et al.,[28] recommend training neck flexion performance to improve neck muscle strength and prevent injuries.

The study has limitations, including gender distribution inequality in sampling, a smaller sample size, and not accounting for age-related differences, physical activity levels, and body fat percentage in obese individuals related to neck muscle endurance. Future studies with larger participants and interventions, including endurance training for individuals with low DNFE and neck pain, are recommended.

Conclusion

The study concludes that obese college students exhibit significantly lower deep neck flexor muscle endurance. This reduced endurance may contribute to an increased risk of developing neck muscle strain, fatigue-related injuries, and forward head posture over time.Early interventions focusing on weight management, postural correction, and physical activity are recommended to prevent neck-relatedmusculoskeletal issues in this population.

Acknowledgments: The authors sincerely express our gratitude to all participants in this study. We would also like to acknowledge SRM Institute of Science and Technology, Chennai, India.

Conflict of Interest: The authors declare no conflict of interest.

Source of Funding: Self-Funding.

References

1. Mohammed MS, Sendra S, Lloret J, Bosch I. Systems and WBANs for controlling obesity. Journal of Healthcare Engineering. 2018 Feb 1;2018.
2. Obesity and overweight [Internet]. [cited 2024 Jan 10]. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.
3. Medvedyuk S, Ali A, Raphael D. Ideology, obesity and the social determinants of health: a critical analysis of the obesity and health relationship. Critical Public Health. 2018 Oct 20;28(5):573-85.
4. Nyberg ST, Batty GD, Pentti J, Virtanen M, Alfredsson L et al., Obesity and loss of disease-free years owing to major non communicable diseases: a multicohort study. The lancet Public health. 2018 Oct 1;3(10): e490-7.
5. Noncommunicable diseases [Internet]. [cited 2024 Jan 10]. Available from: https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.
6. Tomlinson DJ, Erskine RM, Morse CI, Winwood K, Onambélé-Pearson G. The impact of obesity on skeletal muscle strength and structure through adolescence to old age. Biogerontology. 2016 Jun;17:467-83.
7. Kumbhare DA, Balsor B, Parkinson WL, Harding Bsckin P, Bedard M, Papaioannou A, Adachi JD. Measurement of cervical flexor endurance following whiplash. Disability and rehabilitation. 2005 Jul 1;27(14):801-7.
8. Biomechanists explore effects of obesity on falls Febraury 2016, https://lermagazine.com/article/biomechanists-explore-effect-of-obesity-on-falls(last accessed 19 Feb. 22).
9. Sizer Jr PS, Poorbaugh K, Phelps V. Whiplash associated disorders: pathomechanics, diagnosis, and management. Pain Practice. 2004 Sep;4(3):249-66.
10. Hozumi J, Sumitani M, Matsubayashi Y, Abe H, Oshima Y, Chikuda H, Takeshita K, Yamada Y. Relationship between neuropathic pain and obesity. Pain research and management. 2016 Oct;2016.
11. Walsh TP, Arnold JB, Evans AM, Yaxley A, Damarell RA, Shanahan EM. The association between body fat and musculoskeletal pain: a systematic review and meta-analysis. BMC musculoskeletal disorders. 2018 Dec;19:1-3.
12. Grimmer K. Measuring the endurance capacity of the cervical short flexor muscle group. Australian Journal of Physiotherapy. 1994 Jan 1;40(4):251-4.
13. Falla DL, Jull GA, Hodges PW. Patients with neck pain demonstrate reduced electromyographic activity of the deep cervical flexor muscles during performance of the craniocervical flexion test. Spine. 2004 Oct 1;29(19):2108-14.
14. Olson LE, Millar AL, Dunker J, Hicks J, Glanz D. Reliability of a clinical test for deep cervical flexor endurance. Journal of manipulative and physiological therapeutics. 2006 Feb 1;29(2):134-8.
15. Painkra JP, Kumar S, Anwer S, Kumar R, Nezamuddin M, Equebal A. Reliability of an assessment of deep neck flexor muscle endurance test: A cross-sectional study. International Journal of Therapy and Rehabilitation. 2014 May;21(5):227-31.
16. BD Chaurasia. Human Anatomy: Regional and Applied Dissection and Clinical, Head and Neck. 8th ed. CBS Publishers & Distributors Pvt Ltd; 2020.
17. Levangie PK, Norkin CC, et al. Joint Structure and Function: A Comprehensive Analysis. 5th ed. 176 p.
18. Girdhar S, Sharma S, ChaudharyGirdhar S, Sharma S, Chaudhary A, Bansal P, Satija M. An epidemiological study of overweight and obesity among women in an urban area of North India. Indian journal of community medicine: 2016 Apr;41(2):154.
19. Pengpid S, Peltzer K. Prevalence of overweight/obesity and central obesity and its associated factors among a sample of university students in India. Obes Res Clin Pract. 2014 Nov 1;8(6):e558–70.
20. Jarman NF, Brooks T, James CR, Hooper T, Wilhelm M, Brismée JM, et al. Deep Neck Flexor Endurance in the Adolescent and Young Adult: Normative Data and Associated Attributes. PM&R. 2017 Oct 1;9(10):969–75.
21. Domenech MA, Sizer PS, Dedrick GS, McGalliard MK, Brismee JM. The deep neck flexor endurance test: normative data scores in healthy adults. PM R. 2011 Feb;3(2):105–10.
22. Jarman NF, Brooks T, James CR, Hooper T, Wilhelm M, Brismée JM, Domenech MA, Kotara SJ, Sizer PS. Deep neck flexor endurance in the adolescent and young adult: normative data and associated attributes. PM&R. 2017 Oct 1;9(10):969-75.
23. Oliveira AC, Silva AG. Neck muscle endurance and head posture: a comparison between adolescents with and without neck pain. Manual therapy. 2016 Apr 1;22:62-7.

24. Watson DH, Trott PH. Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance. Cephalalgia. 1993 Aug;13(4):272-84.

25. Mayer JM, Nuzzo JL, Chen R, Quillen WS, Verna JL, Miro R, Dagenais S. The impact of obesity on back and core muscular endurance in firefighters. Journal of obesity. 2012 Nov 19;2012.

26. Zele MR, Katke S, Anthikat M et.al. Correlation of reduced endurance capacity of neck flexor and extensor in cigarette smokers of college going students. Int J Health Sci Res. 2021; 11(7): 25-30.

27. Collins CL, Fletcher EN, Fields SK, Kluchurosky L, Rohrkemper MK, Comstock RD, Cantu RC. Neck strength: a protective factor reducing risk for concussion in high school sports. The journal of primary prevention. 2014 Oct;35:309-19.

28. O'Leary S, Jull G, Kim M, Vicenzino B. Specificity in retraining craniocervical flexor muscle performance. journal of orthopaedic & sports physical therapy. 2007 Jan;37(1):3-9.