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Deep Neck Flexor Endurance: A Normative Data Score in Normal Healthy Indian Population

KEYWORDS: Deep Neck Flexors (DNF), Endurance, Indian Population

Alka Pawalia
Teaching Associate, Department of Physiotherapy, Guru Jambheshwar University of Science & Technology, Hisar,Haryana

Vikram Singh Yadav
Assistant Professor, College of Physiotherapy, Pt.B.D.Sharma University of Health Sciences, Rohtak, Haryana, India

Shabnam Joshi
Assistant Professor, Department of Physiotherapy, Guru Jambheshwar University of Science & Technology, Hisar, Haryana

Taruna Verma
MPT Student, Department of Physiotherapy, Guru Jambheshwar University of Science & Technology, Hisar

ABSTRACT *Muscular endurance is the ability of a muscle to generate tension, sustain that tension & resist fatigue over a prolonged period of time against load. Earlier researches states that any challenge to cervical spine flexor endurance could lead to cervical dysfunction, tissue overload, trauma & pain. Since importance of neck flexors endurance is emphasised upon by researchers, our aim was to establish the normative database of neck flexor endurance for the Indian population too. DNF endurance test was done on normal subjects & scores recorded for primary purpose of having a standard research value which could be used for clinical & research purposes. Secondary aim of study was to see for any correlation between DNF endurance & anthropometric measures of neck length & head circumference. The Mean DNF endurance hold time for Indian males was 55.5±25 seconds & for females was 45.2±23 seconds. No significant correlation was observed between DNF endurance & anthropometric variables.*

INTRODUCTION

Cervical spine is most mobile part of the vertebral column. It is surrounded by a complicated meshwork of muscles that contribute to static & dynamic control of the head on neck. However, because of various morphologic differences between the muscle layers that engulf the spine, there is variation in their mechanical effect on the spine (Kamibayashi & Richmond, 1998). Neck muscles are important as they produce motion in the neck when stimulated along with providing a static balance to head on neck, when head is kept in a static position. Muscles of neck run from the base of skull to the back & are divided into categories of anterior & posterior cervical muscles, cervical flexors (superficial & deep) & extensor muscles. Out of these, deep cervical flexor muscles are considered to be an important stabilizer of the head-on-neck posture. Cervical spine function is directly influenced by cervical flexor endurance (Domenech et al, 2011). Cervical flexors, mainly the deep neck flexors are believed to assist in stabilizing the cervical spine during daily gross movements (Harris et al, 2005 & Brandt et al, 2004). It has been demonstrated & proved in various studies that DNF muscles are increasingly active during craniocervical flexion (chin tuck) and individuals who have weak or compromised DNF are more prone to experience neck pain in near future (Deborah et al, 2004). Any compromise to cervical spine flexor endurance activity could lead to cervical related dysfunction, tissue strains, predisposition to injury chances & pain (Harris et al, 2005). There are various factors which predispose to neck pain & also result in reduced DNF endurance, includes sustained awkward posture of head & neck in various desk jobs, long duration of computer use, in dentists & professions involving prolonged working with visual display units (Brandt et al, 2004; Watson et al, 1993; Placzek et al, 1999; Serder et al, 2005). Since muscle function is an important factor in understanding neck pain, by having strong DNFs one can actually prevent future occurrences of the same. (Watson et al, 1993; Placzek et al, 1999; Straker et al, 2000; Jull et al, 2002)

Also the importance of DNF endurance has been cited extensively in literature, it is imperative to have a standard value for the same which could be used for clinical assessment, research and for defining & comparing an average value of any given set of population.

There are many factors that influence a person's perception of the effort he puts to work or exertion. Moreau et al, (2001) in their study mentioned three major psychological issues that influence endurance performance of an individual. These are his personality types, culture of the individual & the task feedback i.e. positive or negative which he receives during the execution of the task. They found that subjects who possess personalities which are motivated by achievement & competition performed better at endurance tasks. Some of the few traits these individuals possessed were competitiveness, self motivation, endurance, self control, tough mindedness, lower rates of perceived exertion, less negative feelings during endurance tasks, control of fatigue and pain (Hellandsig et al, 1998; Raglin et al, 1990; Clingham et al, 1987; Ogilvie et al, 1968). Also Li J (1997) in his work showed that cultural behaviours can affect endurance capacity, it was supported with arguments i.e. performing till fatigue sets in might be more acceptable or be encouraged more in certain cultures than in others. Hence it could limit the results of studies reviewed to certain geographical locations.

According to a study, Japanese have higher endurance times compared to North Americans. It was due to strong cultural value for self determination, diligence, endurance of hardship and concentration in Japanese (Ito et al, 1996). Since these factors will vary from country to country & between various races with cultural variability have

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also been seen in them, one cannot generalize the average values taken in one country for the rest of the population in other countries. While reviewing literature we found only one study which measured DNF endurance in normal healthy individuals for purpose of having a normative data score (Domenech et al, 2011) & since this was done only in North American population, there was a strong need to have a normative database for Indian population too. We also found two studies relating to neck which saw the effect of head circumference and neck length on neck related problems such as headache, altered range of motion, neck muscle strength, endurance & pain, they concluded that those with larger head and longer necks may have developed greater neck muscle endurance capacity as a use effect (Haejung et al, 2005 & Blizzard et al, 2000). Hence it laid the basis for our secondary research aim i.e. to see for any correlation of head circumference and neck length with DNF endurance in normal healthy Indian population.

Since the importance of DNF endurance has been emphasized in literature by many authors, there is a need for establishing a normative data base for the same. So this study was planned to obtain a normative data for DNF endurance in healthy Indian adults and also to determine the correlation of neck length, head circumference with DNF endurance.

METHODOLOGY

The current study followed a cross sectional normative study design, with non random convenient sampling. Prior to conduct of the study institutional ethical approval & an informed consent in writing were obtained from all the participants. Total 212 participants were taken, of which 113 are females & 99 males. To ensure the inclusion of adults from the entire adult lifespan, age group of 20-70 yrs was taken in the study. Subjects above age of 70yrs were excluded because of normal degenerative changes and age related morbidity which could limit them to perform the test procedure and hence affect the results. Participants were included in the study if they were normal healthy individuals within the age range of 20-70 years and excluded if they had any:-

- Headaches within the last years that resulted in limitation of daily activity.
- Symptomatic cervical joints upon cervical spine palpation & examination.
- Complaints/reports of neck or thoracic region pain within the last year.
- Medical diagnosis of systemic, muscular or connective tissue.
- History of significant injury to neck or upper thoracic region.
- History of central or peripheral nervous system disorders.
- History of thoracic or cervical spine surgery.
- Wearing glasses of any type/power.
- History of cancer.

These were taken as exclusion criterion to exclude any biasing as all these factors have been cited to be as causative factors which lead to decreased DNF endurance.

PROCEDURE

Each subjects demographics, including age, height, weight, head circumference, anterior & posterior neck length was recorded. DNF endurance was recorded using DNF endurance test.

Procedure Used to Measure Neck Length & Head Circumference:

Measuring tape was used to measure both neck length & head circumference. Subject was made to sit on a chair with back straight and neck in neutral position. Anterior neck length was measured from angle of mandible to sternal notch and posteriorly it was measured from external occipital protuberance to C7 spinous process which was palpated using mild flexion and extension movement of neck.

For measuring head circumference measuring tape was started from midpoint of the eyebrows and then wrapped around the head & finished again at midpoint of the eyebrows.

Procedure Used for DNF Endurance Test:

While reviewing the literature it has been observed that craniocervical flexion test or chin tuck position to be a reliable method for measuring DNF endurance (Falla et al, 2003). So of the various methods available to measure DNF endurance, one given by Harris et al (2005) & Olson et al (2006) was chosen for the study due to its simplicity and nature of clinical setup which does not require any sophisticated lab equipment. Also this method has a good to excellent interrater & intrarater reliability. Test was performed with subject in supine and hook lying position and hands resting on the abdomen in beginning. Subject was then requested to tuck the chin maximally, while maintaining it in isometric contraction subject lifted the head & neck approximately 2.5 cm from resting position. While maintaining this position, a line was drawn across two approximated skin folds along the subject's anterior-lateral neck. Therapist then slides the widths of stacked index & middle fingers under the subject's head at the most posterior aspect of occiput. Subject was then asked to relax the neck, resting the head on the tester's fingers. Next, the subject again was directed to "tuck the chin" completely and then raise the head to the point that the back of the subject's head maintained contact with tester's stacked fingers. During the test, examiner gently moved the stacked fingers side to side under the subject's head, which provided a tactile cue for maintaining proper head position above the plinth. Time recording was started when the subject raised head and was terminated when one of the following four criteria was met:

(1) Loss of straight line over skin fold as chin tuck position was lost.
(2) The subject's head rested on the therapist's folded fingers for more than 1 second.
(3) The therapist noted when the subject raised head above the folded fingers such that there was no longer contact with the therapist's fingers.
(4) The subject was not able to continue the test position.

The subject was informed and allowed to correct himself only once when deviated from the test position and corrected by providing verbal cue ("tuck your chin" or "hold your head where you just slightly feel my fingers") that directed the subject to resume the proper position and continue the trial. Subject was tested twice, with a 5-minute break between tests to allow muscular recovery. During this time, subject was instructed to remain supine and turn the neck from side to side through a pain-free range of motion as the subject felt warranted, without raising the head from the table. The two time scores were averaged, and the result was recorded.

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DATA ANALYSIS

Data was analysed using SPSS version 21.0. To determine reliability among the testers for test procedure used to measure DNF endurance, ICC was calculated with inter-rater (ICC 0.88) and intra-rater (ICC 0.80) values. Subjects were divided in various age groups of 20-30, 31-40, 41-50, 51-60 & 61-70 Yrs for analysis. For DNF endurance descriptive statistics was used to express as mean & standard deviation. Unpaired t-test was used to compare the DNF endurance in male & female subjects. Karl Pearson's correlation coefficient was calculated to check for correlation of DNF endurance with neck length and head circumference.

RESULTS

Aim of current study was to obtain normative data for DNF endurance values in Indian population. Table 1 shows demographic characteristics of the subjects as per age group. Descriptive Statistics expressed as mean and standard deviation for DNF endurance are shown in Table 2. Results also show males (55.5±25 secs) having a higher endurance than females (45.2±23 secs), t = 3.1235 with df=210 ($P \leq 0.001$). The study also showed no significant correlation between DNF endurance and anthropometric measures of neck length and head circumference.

TABLE 1: Demographic Characteristics of subjects

Age Group (Yrs)	No of Subjects		Mean±SD											
			Age (Yrs)		Height (Cms)		Weight (Kgs)		Head Circumference (Cms)		Anterior Neck Length (Cms)		Posterior Neck Length (Cms)	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
20-70	99	113	43.5±14	41.2±15	166.9±7.3	158.3±7.2	65.2±10	61.2±12	56.6±1.5	55.3±1.6	13.6±1.06	13.2±1.08	10.4±1.3	9.9±1.17
20-30	21	37	23.7±3.7	24.9±2.7	170.4±6.3	157±8	64±8	56.4±9	56.2±1.3	55.2±1.4	13.8±0.8	13.4±0.92	11.5±1.2	10.1±1.1
31-40	20	22	35.4±3.4	35±3	167.9±5.9	158±5.1	69.5±12	61.5±12	57.4±1.7	55.4±1.5	13.5±1.19	13±1.18	10.6±1.4	10.2±1.3
41-50	24	19	45.2±2.9	45.8±2.5	167.7±5.1	159.2±7.4	64.3±12	63.1±14	56.5±1.2	55.6±2	13.9±0.97	13.8±0.94	10±1.1	10.1±1.3
51-60	20	20	55.4±3.1	56.2±3.3	161.9±10	159±6.5	65.2±9	65±11	56.8±1.6	55.6±1.5	13.5±1.09	13±1	10.3±1	9.57±1
61-70	14	15	65±2.5	64.6±2.3	166±6.3	160±9	62.3±8	65.3±11	56±1.27	54.6±1.7	13.4±1.24	12.8±1.29	9.5±1.2	9.16±0.8

TABLE 2: Mean values for DNF Endurance

Age Group (Yrs) ↓	No of Subjects		DNF Endurance (Secs) Mean±SD		t-value	P-value ≤
Gender →	Males	Females	Males	Females		
20-70	99	113	55.5±25	45.2±23	3.1235*	0.001
20-30	21	37	64.4±33	46.4±30.5	2.0971*	0.025
31-40	20	22	59.4±25	51.7±26	0.9762	-
41-50	24	19	56.8±23	43.6±12	2.2657*	0.025
51-60	20	20	51±20	41.6±13.8	1.7300*	0.05
61-70	14	15	40.8±15	39.4±12.5	0.2738	-

DISCUSSION

For present study sample size of 212 subjects covering the age groups from 20 to 70 years was taken & primary purpose was to establish the average hold time for DNFs endurance test in Indian subjects without neck pain. Results of the study demonstrated that the mean value of DNF endurance in Indian subjects without neck pain was 55.5±25 seconds for males and 45.2±23 seconds for females. Similar study done by Domenech et al, (2011) reported an average hold time of 39.1 & 29.3 seconds for males & females respectively in North American population.

According to findings of the current study (Table 2) DNF endurance time for males was approximately 10 seconds longer than for females, which are consistent with findings of the study done by Domenech et al (2011).

Also Indian subjects showed higher values of DNF endurance when compared with North American subjects. This variability could have been due to the differences of personality type and cultural behaviours of the two countries where these studies were planned. These two differences were also reported by Moreau et al, (2001) in their study as two major psychological factors out of three factors which influence endurance performance of an individual. The third factor of task feedback was similar for both the set of population i.e. any feedback whether positive or negative was not given to the subjects during the performance of the endurance test hence it has limited to no chances of influencing the final outcome.

The findings of the study showed that age, neck length & head circumference does not have correlation with DNF endurance in both males and females. Literature review showed only one study which concluded that subjects with larger heads and longer necks performed better on neck extensor endurance test i.e. a small but significant positive relationship between the magnitude of the torque experi-

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enced at the neck in prone and endurance time (Haejung et al, 2005).

DNF endurance enhances cervical spine function, any challenge to it could lead to negative impact on cervical spine and the adjoining musculoskeletal structures and their function (Kamibayashi et al, 1998; Raglin et al, 1990; Clingham et al, 1987 & Grimmer 1994). Various studies have shown that DNF weakness and endurance deficits appear to correspond with the inability to sustain craniocervical flexion in an inner-range position which is an important movement of head and neck complex (O'Leary et al, 2007). This control deficit along with increased cervical spine lordosis acts as a contributor to the pathogenesis of head and/or neck pain and other musculoskeletal deficits in the neck region (Brandt et al, 2004; Deborah et al, 2004; Watson et al, 1993; Placzek et al, 1999). Hence strong DNFs with good muscle endurance can contribute in preventing various neck related pathologies.

RELEVANCE FOR CLINICAL PRACTICE

Average DNF endurance in healthy Indian males was 55.5±25 seconds and in females was 45.2±23 seconds. This is the first normative data base for DNF endurance values of normal healthy Indian population. It gives a standard average value of DNF endurance which could be utilised as a reference measure to compare neck muscle endurance capacities for various pathological and non pathological clinical conditions. This could be of great use in clinical decision making and practical approaches relating to neck related pathologies helping health practitioners and therapists in their more elaborate assessment and treatment directed goals.

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