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Cardiovascular and Respiratory Responses of Apparently Healthy Participants to Cervical Traction in Sitting Position Using Different Weights

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Authors' contributions

This work was carried out in collaboration between all authors. Author AVE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author CO managed the literature searches and data collection, author ECO helped in statistical data analysis, meanwhile, authors AOE and CIE helped in drafting of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background and Aim: Cervical Traction (CT) is a vital physiotherapeutic modality in the management of cervical musculoskeletal disorders. This study determined the cardio-respiratory responses to CT using different percentage body weights on Apparently Healthy Individuals (AHI).
Materials and Methods: 163 consecutively recruited AHI that met the inclusion criteria were randomly assigned into three groups (A, B and C) that were subjected to CT weights of 7.5%, 10%

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and 15% of their total body weights respectively. Participants' systolic (SBP) and diastolic (DBP) blood pressure, Pulse Rate (PR), Respiratory Rate (RR) and Inspiratory Capacity (IC) was recorded before and after traction. The side-effects reported by participants during and after traction were also recorded using a previously validated 8- item self-administered questionnaire.
Data was analyzed using Paired t-test, Independent t-test, Chi square test and One-way ANOVA.
Results: IC and PR significantly changed across the three groups post-traction. RR significantly changed in groups B and C post-traction but not in group A. SBP and DBP showed no significant differences in any of the group post-traction. The participant's side effects of pain in the neck or arm, dizziness and shortness of breath were found to be significantly associated with cervical traction across the three groups, ($p < 0.05$; CI=0.00-0.00).
Conclusion: CT alters the cardiovascular and respiratory system leading to side effects that increase with increased traction weight. Use of a minimum weight for CT is recommended.

Keywords: Cervical-traction; cardiovascular; respiratory; responses.

1. INTRODUCTION

Traction is the act of drawing or pulling that relates to forces applied to the body to stretch a given part or to separate two or more parts [1]. It is employed in the management of disorders of cervical or lumbar spine with the goal of relieving pain in/ or originating from those areas [2]. Cervical traction is the act of pulling or stretching the head away from the rest of the body to release tension and pressure on neck structures [2]. It applies a stretch to muscles, ligaments, and tissue components of the cervical spine [3]. Cervical traction is intended for patients with musculoskeletal disorders or nerve compression of the cervical spine, with the goal of restoring function by relaxing muscle spasms; decompressing spinal structures to reduce nerve-root irritation; increasing joint mobility; and stretching muscles and ligaments adjacent to the vertebral bodies [4]. Cervical traction has been widely used effectively in the treatment of cervicobrachial pain reduction both as continuous or intermittent mode and to improve quality of life for patients with chronic neck disorders [2].

Cervical traction force is usually applied to the cervical spine through a series of weights or a fixation device, and requires that the patient is either kept in supine position or placed in a sitting position [3]. The force necessary to distract the cervical spine was recommended to be approximately seven percent of the body weight with an angle of pull of thirty degrees [5]. Akinbo et al. [6], however, found that 10% of body weight was ideal for pain and mobility. Alternatively Colachis and Strohm [7] reported twenty-five to thirty degrees as the ideal angle of pull for the weights chosen by clinicians. In as much as cervical traction is beneficial in the management of musculoskeletal disorders or nerve compression of the cervical spine, it can induce some side-effects [4,8].

The side effects that can emanate from cervical traction may include severe pain in the neck and arm; weakness that is not due to overexertion; a sensation or feeling of lack of balance or equilibrium, nausea, mild headache, blurred vision, and migraine; most of which suggest a perturbation of the patient's cardiovascular system [8], and may be dependent on the traction weight and position [9]. Some patients also experience mildly difficult or labored breathing, suggesting a perturbation of the respiratory system; thus raising a question on whether traction therapy has any effect on the cardio-respiratory system of the treated patient during and after therapy [9].

Cardio-respiratory coordination is a concept based on physics that aims to quantify the interaction between respiratory and heart rhythm, assuming they are generated by two independent systems [10]. Several studies have been carried out on the cardiovascular responses to cervical traction [11-13]. However, there is a dearth of research on the changes in respiratory system parameters following cervical traction. In general, most of the studies carried out on cardiovascular response during cervical traction were on patients with cervical spondylosis [5,11]. However, there were controversies over the results obtained from such studies as patient's condition may affect some changes on cardiovascular parameters hence the need to study apparently healthy people. Based on the existing problems, this study sought to determine the respiratory and cardiovascular responses to cervical traction using different percentage body weights on apparently healthy individuals.

2. MATERIALS AND METHODS

2.1 Research Design

This study employed an ex-post facto design, involving one hundred and sixty three undergraduate students of Nnamdi Azikiwe University, Nnewi campus, Anambra State, Nigeria.

2.1.1 Inclusion criteria

Participants were between the ages of 18-30 and certify to have no disease of the cardiovascular, respiratory and nervous systems from a pre-study clinical assessment by a physician. Subjects were considered apparently healthy if they were asymtomatic, had no physical disability and believed to be in a good state of health.

2.1.2 Exclusion criteria

Participants were excluded if they had cervical pain or cervical spondylosis; had unstable cardiovascular and respiratory system as indicated by their resting blood pressure, pulse rate, respiratory rate and capacities; were on antihypertensive drugs; had history of joint hypermobility and history of cervical traction treatment.

2.2 Ethical Consideration

Before commencement of the study, ethical approval was obtained from the Ethical Review Committee of Nnamdi Azikiwe University Teaching Hospital, Nnewi.

2.3 Sampling Technique

Consecutive non-probability sampling technique was used to recruit volunteering participants who met the inclusion criteria and signed the consent form.

2.4 Experimental Protocol

The participants' socio-demographic and physical variables, blood pressure (systolic and diastolic), pulse rate, respiratory rate and inspiratory capacity (using spirometry) were recorded using standard procedure according to Kim et al. [14] and Pan et al. [13]. The participants were assigned into three groups (A, B and C) using the Fischer's bowl method of random assignment, group A was assigned 55 participants while group B and C had 54 participants each [15].

Each participant was made to sit upright on a wooden chair such that the ankles, knees and hips were at 90 degrees, the psychometric property of the cervical traction was established by previous studies [6,10,16]. A 10-minute sustained cervical traction was then applied by means of a halter of a cervical traction system (vissco brand, made in Mumbai) aimed to give equal pull on the mandible and the occiput using a simple rope and pulley system. The body weights of the participants was determined using a weighing scale (Hanson, Ireland) and the percentage body weights of participant calculated for each group individuals by dividing participants weight/100 multiply by 7.5, 10 and 15 for groups A, B and C respectively. Group A received cervical traction using 7.5% of their total body weight; group B received cervical traction using 10% of their total bodyweight; while group C received cervical traction using 15% of their total bodyweight. Each participant was then examined for the following side effects during and 5 minutes after traction: Using an 8-item previously validated self-administered questionnaire that sought information on the following side effects; mild headache, blurred vision, migraine, weakness, pain in the neck and or arm, dizziness or lack of balance, shortness of breath, and any other side effects that might be peculiar to each individual [17]. The blood pressure (systolic and diastolic), pulse rate, respiratory rate and inspiratory capacity were also recorded within 5 minutes after traction.

2.5 Statistical Analysis

Data were analyzed using descriptive statistics of mean and standard deviation to summarize the demographic variables (age, weight, height). The Kolmogorov test for normality was done to determine that the data collected were normally distributed, while inferential statistics was done using paired t-test to test the pre and post traction changes for each group separately. Independent t-test was used to compare gender difference in response to cervical traction, changes for each group. One way ANOVA was used to compare the effects of the three traction weights with a Post Hoc test to determine where the difference lies across the three groups. Alpha level was set at 0.05.

3. RESULTS

One hundred and sixty three participants (49.7% females and 50.3% males) with mean age of 22.86±2.30 years were involved in the study. Kolmogorov_Smirnov test of the variables obtained were normally distributed (p-values ranged from 0.517 to 0.836). The participant's demographic and physical distributions were summarized in Tables 1 and 2.

Generally, one hundred and one (61.9%) participants reported at least one side effect after the traction application, with 56.6%, 62.3% and 66.7% of the participants in groups A, B and C respectively reporting at least one side effect. The report of mild headache, blurred vision, migraine, and weakness were not significantly associated with cervical traction ($p > 0.05$), while report of pain in the neck or arm, dizziness and shortness of breath were significantly associated with cervical traction across the three groups, ($p < 0.05$) see Table 3.

There were significant changes in the inspiratory capacity after cervical traction across the three groups but there were significant changes in respiratory rate only groups B and C (Table 4). There was no significant gender difference in cardiovascular and respiratory responses to cervical traction (Table 5). There were no significant differences in the changes in systolic and diastolic blood pressure post-traction across the three groups, but there were significant differences in the changes in pulse rate and inspiratory capacity post-traction across the three groups (Table 6). Post-Hoc analysis shows that these differences in pulse rate and inspiratory capacity post-traction lie between Group A (7.5% weight) and each of Group B (10.0% weight) and Group C (15.0% weight) but not between Groups B and C (Table 7).

Table 1. Socio-demographic profile of participants

Variables	Mean ± Standard deviation			Total
	Group A	Group B	Group C	
Age (years)	22.8±2.1	23.3±2.4	22.4±2.2	22.8±2.3
Height (meter)	1.68±0.08	1.71±0.08	1.69±0.08	1.69±0 .09
Weight (Kg)	65.1±10.8	66.5±7.5	65.2±9.2	65.6±9.2
BMI (Kg/m^2)	23.0±3.6	22.6±2.9	22.7±3.0	22.8±3.2

Key: Group A: Participants subjected to 7.5% of body weight; Group B: Participants subjected to 10% of body weight; Group C: Participants subjected to 15% of body weight; BMI: Body mass index

Table 2. Gender distribution of the participants

Gender	Frequency (n)/Percentage (%)			Total
	Group A	Group B	Group C	
Females	29(54.7)	23(43.4)	29(50.9)	81(49.7)
Males	24(45.3)	30(56.6)	28(49.12)	82(50.3)

Key: Group A: Participants subjected to 7.5% of body weight; Group B: Participants subjected to 10% of body weight; Group C: Participants subjected to 15% of body weight;

Table 3. Association of participants' side effects with cervical traction in sitting position across the three groups (95% confidence interval)

Side effects	Frequency distribution (n)				χ2	P value
	Group A	Group B	Group C	%total		
Mild headache	14	13	12	23.9	0.1	0.92
Blurred vision	1	3	5	5.5	3.9	0.19
Migraine	0	0	1	0.6	3.0	0.33
Weakness	11	10	12	20.2	0.2	0.86
Pain in neck and/or arm	13	21	25	36.1	6.6	0.03*
Dizziness or lack of balance	6	14	16	22.0	6.4	0.01*
Shortness of breath	6	19	21	28.2	17.1	<0.01*

Table 4. Paired t-test comparing pre- and post-traction cardiovascular and respiratory parameters in each of the three groups (95% confidence interval)

Group	CRP	Mean ± Standard deviation		t	P
		Pre-traction	Post traction		
Group A	SBP (mmHg)	117.5±10.9 12.8 -14.1	119.2±13.6 114.3-15.4	-1.8	0.18
	DBP (mmHg)	71.3±9.6 66.2-7.1	74.0±13.1 70.6-10.8	-1.7	0.08
	PR (b/m)	73.0±9.1 69.4-5.1	75.0±11.0 71.3-8.8	1.9	0.05
	RR (c/m)	17.5±3.0 15.4-.2.0	19.7±2.3 16.3-3.4	-1.1	0.05
	IC (ml)	1463.9±562.3 1412.8-554.1	1623.2±565.9 1617.3-552.4	-162.6	0.01*
Group B	SBP (mmHg)	126.6±l2.3 120.6-11.4	127.3±15.1 123.1-13.2	-0.4	0.79
	DBP (mmHg)	78.8±12.1 70.9-9.6	79.0±14.5 71.5-9.3	-0.1	0.97
	PR (b/m)	76.1±10.4 65.1-.9.1	74.3±10.9 68.2-7.6	1.5	0.98
	RR (c/m)	18.8±7.5 14.3-.5.1	19.8±3.8 15.8-4.5	-2.2	<0.001*
	IC (ml)	1515.0±559.2 1498.2-536.1	1389.6±618.5 1347.6-612.4	138.7	0.01*
Group C	SBP (mmHg)	124.7±15.7 118.2-10.4	123.4±13.6 116.4-10.1	1.2	0.52
	DBP (mmHg)	67.6±11.1 60.9-7.6	69.3±12.6 61.9-6.3	-1.7	0.31
	PR (b/m)	72.8±11.5 62.0-.7.5	72.2±10.4 64.2-9.1	0.6	0.54
	RR (c/m)	17.7±2.9 12.4-.4.3	18.8±3.2 14.2-5.5	-1.1	0.01*
	IC (ml)	1643.8±704.7 1556.8-672.9	1647.3±711.9 1569.2-703.1	-1.1	0.02*

*Key: *=Significant at α < 0.05; SBP=systolic blood pressure; DBP=diastolic blood pressure; PR=pulse rate; RR=respiratory rate; IC=inspiratory capacity*

4. DISCUSSION

The present study was aimed at investigating the respiratory and cardiovascular response to cervical traction using different percentage body weights of apparently healthy individuals. The findings from this study revealed that there were no significant changes in systolic and diastolic blood pressures and pulse rates on cervical traction application using 7.5%, 10% or 15% of participants' body weight. This is in agreement with the findings of Akinbo et al. [5] on effect of 7.5% and 10% of cervical traction weight on patients with cervical spondylosis and apparently healthy individuals respectively. Hseuh, [9] also reported no significant change in systolic and diastolic blood pressure post-traction in apparently healthy women using 10% of participants' body weight. However, this is contrary to the report of Balogun et al. [17] in which there was a significant increase in blood pressure following cervical traction among apparently healthy women in Canada. Akinbo et al. [5,6] also reported significant drop in systolic and diastolic blood pressure following cervical traction with 10% and 15% of participant's body weight respectively among cervical spondylosis patients in south western Nigeria. The disparities in results between the present study and those of Akinbo et al. [5,6] and Balogun et al. [17] may be due to differences in the characteristics of the participants considered in the studies. In addition to recruiting participants with cervical spondylosis, the mean age (54.94±8.40 years) of the participants in Akinbo et al. [5,6] studies was much older than that (22.86±2.30 years) in the present study. According to Brian et al. [18] increasing age and arterial pressure act independently to reduce baroreflex activity. Even though the present study did not record any significant difference in gender responses post-traction, the fact that Balogun et al. [17] recruited only women as against the present study that recruited almost equal distribution of male and female participants, might have contributed to the differences in results between the two studies. The lack of significant difference between pre- and post-traction pulse rates in groups B and C with percentage body weights of 10 and 15% is in line with the findings of Akinbo et al. [5] and Chien-Tsung et al. [19] but contrary to the report by Balogun et al. [17].

Unlike in the groups that were subjected to 10% and 15% of participants' body weight; the present study revealed no significant changes in respiratory rate on cervical traction application in the group subjected to 7.5% participants' body weight. The inspiratory capacity significantly reduced post-traction in participants that were subjected to 7.5% of the body weight but significantly increased in those that were subjected to 10% and 15% of the body weight. The pressure of the traction belt of cervical traction has been shown to cause stretching of baro-receptors found in the carotid sinuses [18]. The stimulation of baro-receptor has been found to induce slowing of the heart, causing a decrease in arterial blood pressure with resultant tissue hypoxia and rise in the pressure of carbon dioxide that can be sensed by the chemo-receptors in the carotid and aortic bodies and the medulla oblongata, thus resulting in increased pulmonary ventilation [14]. This effect will

Table 5. Independent t-test comparing post-traction gender changes in cardiovascular and respiratory parameters in each of the three groups (95% confidence interval)

Group	CRP	Mean ± Standard deviation		t	P
		Females	Males		
Group A	SBP (mmHg)	-0.7±7.4 -0.4-6.1	-2.4±13.0 -1.3-15.9	0.6	0.55
	DBP (mmHg)	-1.0±7.8 -0.5-8.9	-5.2±10.1 -3.7-12.4	1.6	0.10
	PR (b/m)	-3.4±7.6 -2.5-7.9	-1.3±5.6 -0.7-7.6	-1.1	0.29
	RR (c/m)	-2.2±2.7 -1.5-3.2	-1.9±3.8 -0.8-4.1	-0.4	0.70
	IC (ml)	-1.8±396.6 -0.9-425.2	-1.9±445.5 -1.1-478.1	0.1	0.93
Group B	SBP (mmHg)	2.2±15.9 -1.2-18.6	-3.6±8.9 -2.2-12.4	1.6	0.11
	DBP (mmHg)	1.0±14.0 -0.5-16.2	-1.3±8.9 -0.7-11.0	0.6	0.52
	PR (b/m)	-0.1±6.7 -0.07-7.5	4.0±7.8 -3.5-8.5	-2.1	0.04
	RR (c/m)	-1.7±3.0 -1.1-4.0	-2.2±3.2 -1.6-4.0	0.6	0.55
	IC (ml)	2.3±436.9 -1.9-445.3	40.3±252.1 -37.2-264.9	1.9	0.06
Group C	SBP (mmHg)	2.2±14.8 1.6-15.6	0.1±13.7 0.06-14.6	0.5	0.58
	DBP (mmHg)	0.4±13.5 -0.09-14.1	-1.5±14.5 -0.8-16.7	0.52	0.60
	PR (b/m)	1.5±9.1 1.1-11.2	-0.8±6.2 -0.6-7.5	1.1	0.26
	RR (c/m)	-0.3±3.1 -0.1-4.7	-0.5±9.2 -0.3-10.9	0.1	0.92
	IC (ml)	6.9±377.6 -5.6-384.2	17.8±585.9 13.5-598.3	-0.1	0.93

*Key: *=Significant at α < 0.05; SBP=Systolic Blood Pressure; DBP=Diastolic Blood Pressure; PR=Pulse Rate; RR=Respiratory Rate; IC=Inspiratory Capacity*

Table 6. ANOVA test comparing changes in cardiovascular and respiratory parameters across the groups in sitting position (95% confidence interval)

CRP	Mean ± Standard deviation			F	P
	Group A	**Group B**	**Group C**		
SBP (mmHg)	-1.3±9.8 -0.6-11.3	-0.6±13.2 -0.3-14.6	1.2±14.2 -0.7-16.4	0.6	0.53
DBP (mmHg)	-2.6±8.9 -1.5-10.5	-0.1±13.3 -0.07-14.1	-0.5±13.9 -0.2-14.2	0.6	0.53
PR (b/m)	-2.6±6.9 -1.7-8.7	1.8±7.5 1.3-10.6	0.4±7.8 -0.06-11.4	0.49	0.01*
RR (c/m)	-2.1±3.1 -1.8-5.2	-1.9±3.1 -0.5-4.6	-0.4±6.7 -0.06-7.5	2.1	0.12
IC (ml)	-1.8±411.5 -0.9-421.8	1.3±368.1 -0.8-414.6	12.2±486.7 10.7-498.2	7.8	0.01*

*Key: *=Significant at α < 0.05; SBP=Systolic Blood Pressure; DBP=Diastolic Blood Pressure; PR=Pulse Rate; RR=Respiratory Rate; IC=Inspiratory Capacity*

Table 7. Post hoc analysis (least significant difference) comparing changes in cardiovascular and respiratory parameters across the groups in sitting position (95% confidence interval)

Variable	Group	Group	P
SBP (mmHg)	Group A	Group B	0.79
		Group C	0.28
	Group B	Group C	0.43
DBP (mmHg)	Group A	Group B	0.39
		Group C	0.37
	Group B	Group C	0.86
PR (b/m)	Group A	Group B	0.00*
		Group C	0.04*
	Group B	Group C	0.30
RR (c/m)	Group A	Group B	0.87
		Group C	0.07
	Group B	Group C	0.10
IC (ml)	Group A	Group B	0.00*
		Group C	0.02*
	Group B	Group C	0.12

*Key: *=Significant at α < 0.05; SBP=systolic blood pressure; DBP=diastolic blood pressure; PR=pulse rate; RR=respiratory rate; IC=inspiratory capacity*

logically be more pronounced with greater amount of traction weight, and this may thus explain why participants that were subjected to heavier weight (10% and 15%) experienced significant increases in respiratory function such as significantly higher pulse rate and inspiratory capacity (p> 0.05) as observed in Table 6. Some of the alterations in the cardiorespiratory parameters of the participants in the present study might have also been due to anxiety, which has been previously reported to increase cardiorespiratory functioning [20]. However, the fact that there were significant differences in the levels of alterations in cardiorespiratory parameters across the three groups with different traction weights might make it easy and logical to ascribe these differences in levels of alteration to variation in traction weights. Furthermore, instead of increasing, inspiratory capacity significantly reduced post-traction in participants that were subjected to 7.5% of the body weight.

In the present study, 61.9% of the participants reported at least one side effect after undergoing cervical traction. This is in agreement with previous studies that associated cervical traction to perturbation of the cardiovascular and respiratory systems, resulting in side effects [5,6,18]. Some of these side effects (such as dizziness or lack of balance, shortness of breath) can be as a result of the effect of cervical traction on the cardio-respiratory system, which logically will be more pronounced with greater pull. This may thus explain why the participants subjected to heavier weights experienced more side effects than their counterparts subjected to lighter weights. Pain in the neck or arm reported by the participants may just be the result of the mechanical effect of the cervical traction on the cervical muscles, ligaments, and tissue, which will also understandably be more pronounced with heavier traction weights. Some of the reported side effects that were found to be significantly associated with cervical traction across the three groups such as pain in the neck or arm, dizziness or lack of balance and shortness of breath might also be as a result of vasovagal response which usually results to decrease in supply of blood to the brain [21]. The vasovagal response might have been triggered by any of the following: sitting position of the participants; insufficient time between termination of the procedure and standing up of participants; and physical pain induced by the traction procedure. The fact that these side effects were also reported among apparently healthy individuals may suggest that these side effects, as recorded in patients with cervical spondylosis [6] may not be entirely attributed to their pathological state but rather may be the result of normal physiological response of the body to cervical traction. Thus, there is the need to apply caution while administering cervical traction to patients with cardiorespiratory diseases including hypertension, heart attack, or any serious cardiac or pulmonary problems. This is because these relatively harmless physiological responses to cervical traction can be accentuated to harmful levels in individuals with diseases of the cardiorespiratory system. In a situation where cervical traction must be applied in this group of patients, it should be done with minimal weight.

Following the findings of the present study, it is recommended that a minimum percentage of body weights be used generally for cervical traction as it seems safer than using greater percentage body weights. Several side effects reported by patients with cervical spondylosis were also found among individuals without cervical spondylosis, and therefore should be taken as inherent effects of cervical traction, rather than attributing them to underlying pathology of patients with cervical spondylosis or gender. However, future studies with a randomized control trial design may be needed to ascertain robust causal inferences on the relationships between percentage of body weights and cardio-respiratory responses of patients receiving cervical traction treatment.

5. CONCLUSION

This study suggests that application of cervical traction with the use of a minimum percentage body weight will lower the incidences of side effects associated with cervical traction treatment. There was no significant gender difference in response to cervical traction.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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