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Morphological Status of Cervical Vertebrae (C3-C7) in Patients Referred to Taleghani Hospital in Kermanshah, Iran

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Abstract

Background and purpose: The neck has the greatest spine motion due to two special vertebrae connected to the skull. Its unnatural position causes uneven appearance and physical injuries. This study investigates the morphological status of cervical vertebrae.

Materials and methods: This cross-sectional study was conducted on the morphological status of the neck of 450 patients referred to Taleghani Hospital who were randomly selected and performed using SPSS22 software. For comparison of quantitative variables, paired t-test and ANOVA were used and for qualitative variables, *Chi-square* test was used. The significance level in all cases was less than 0.05.

Findings: Vertebrae C4, C5, C7 in SVBW, C3, C4 in SVBl, C4, C5 in IVBW, C6 in AVBH, C3, C4 in PVBH, C6, C7 in SVFW in men and women, C3, C5 in SVBW, C3, C4 in SVBl, C4 in IVBW, C4, C5 in PVBH, C6 in SVFW, C3 in SVFL in different ages, also C5, C6 in SVBW, C3, C4 in IVBL, C5 in PVBH in different heights, C4 in SVBW, C5, C6, C7 in SVBl, C3, C4 in IVBW, C3, C5 in IVBL, C4 in PVBH, C3 in SVFW, C6 in SVFL among different religions, C3, C4, C5 in SVBW, C3 in SVBl, C3 in IVBW, C7 in IVBL, C6 in AVBH, C6, C7 in PVBH at different BMI have significant differences (p<0/01).

Conclusion: The width, length and height of vertebral bodies of levels C3-C7 in men and age over 60 years, heights over 180 centimeters and higher BMI people are larger and wider than others.

Keywords: Morphological status; Cervical spine; Patients; Cervical vertebrae

Introduction

The cervical spine consists of seven vertebrae C1-C7 that are the smallest part of the vertebral column. The vertebrae and intervertebral discs create spaces that allow the spinal nerves to exit. The cervical vertebrae, as a group, produce a lordotic curve. This is while the cervical vertebrae have the most morphological features, the cervical vertebrae have several distinctive features compared to the lumbar or thoracic vertebrae, the most noticeable difference being the presence of a foramen in each transverse process (except C7). These transverse foramina enclose the vertebral arteries. Another unique feature of the cervical vertebrae is that they have the highest intervertebral disc height, which increases the range of motion [1]. The spine is also important due to its vital role in protecting the spinal cord and spinal nerve branches, supporting the thorax and abdomen, and enabling flexibility and mobility of the body and neck rotation. Therefore, identifying the pathological processes of the vertebrae largely depends on determining a standard for the vertebrae and their evolutionary and dynamic process [2]. Various factors such as age, sex and ethnicity, trauma, congenital defects and behavioral habits affect the anatomy of the cervical vertebrae [3]. One of the factors affecting the shape and appearance of the cervical spine is the aging process, which ultimately leads to cervical spine instability, disc herniation, spinal stenosis in the vertebral foramen and changes in the vertebral joint level. Another important factor affecting the morphology of the cervical vertebrae in traumatic cases is that in Iran, after cardiovascular diseases, it is the second cause of death. Only 2 to 3 percent of non-penetrating traumas involve cervical injuries, but due to the high mortality rate and complications resulting from it, it is very important. Most cervical fractures occur at two levels. About a third of them occur at the C2 level and half of the injuries occur at the C6 or C7 level. Most fatal cervical spine injuries occur at the upper neck levels, especially at the cranio-cervical C1 or C2 site. Research suggests that mastering the precise anatomy of the cervical spine (C1-C7) and its relationship with the vertebral arteries can significantly reduce unwanted damage to the vital structures of this area. Considering the prevalence of spinal complications and their harmful effects and also the necessity of knowing the factors affecting the morphological status and also due to the lack of accurate and consistent studies that have examined the morphological status of the cervical spine, the aim of the present study was to focus on identifying the factors affecting the morphological status of the cervical spine.

Materials and Methods

This cross-sectional study examined the morphological status of the cervical spine of patients with neck trauma referred to Taleghani Hospital in Kermanshah. The data collection tools in our study included checklists with demographic information and file information. The required sample size was calculated to be 450 patients, which included 302 men and 148 women, who were randomly selected and entered the study according to the date of referral. In this study, the initial CT-scans of the patients were examined and patients with acute or previous cervical fracture were not included in the study. The patients were divided into three age groups of 20-39, 40-59 and over 60 years [4,5]. In this study, the morphological status of the cervical spine of the patients was measured by indices of superior vertebral body wider, superior vertebral body length, inferior vertebral body wider, inferior vertebral body length and also measurements related to the width and height at each disc level (anterior vertebral body high and posterior vertebral body high) and these measurements (superior vertebral foramina wider, superior vertebral foramina length, length of right and left superior facet) were performed in the mid-sagittal plane.

Results

Findings

Out of 450 subjects, about 67% were male and 176 (39.1%) were 20 to 39 years old, 168 (37.3%) were 40 to 59 years old and 106 (23.6%) were over 60 years old. The mean height and BMI of the subjects were 173.51 ± 10.459 and 28.126 ± 3.918, respectively [6].

The results showed that C4, C5 and C7 vertebrae in superior vertebral body wider, C3 and C4 vertebrae in superior vertebral body length, C4 and C5 vertebrae in inferior vertebral body wider, C6 vertebra in anterior vertebral body high, C3 and C4 vertebrae in posterior vertebral body high and C6 and C7 vertebrae in superior vertebral foramina wider had significant differences between men and women ($p<0.01$) and the mean of these vertebrae (in terms of height, width and length) were higher and wider in men than women (**Table 1**).

Table 1: Demographic characteristics of patients with morphological problems of the cervical spine (C3-C7).

Variable		Mean (N)	Standard deviation (%)
Age	20-39	176	39.1
	40-59	168	37.3
	>60	106	23.6
Gender	Male	302	67.1
	Female	148	32.9
Religion	Shia	312	69.3
	Sunni	115	25.6
	Others	23	5.1
Height		173. 51	10.459
BMI		28.126	3.918

The results indicated that C3 and C5 vertebrae in superior vertebral body wider, C3 and C4 vertebrae in superior vertebral body length, C4 vertebra in inferior vertebral body wider, C4 and C5 vertebrae in posterior vertebral body high, C6 vertebra in superior vertebral foramina wider and C3 vertebra in superior vertebral foramina length had significant differences among different ages ($p<0.01$) and the mean of these vertebrae (in terms of height, width and length) were higher and wider in ages over 60 years than lower ages (**Table 2**).

Table 2: The relationship between gender and morphological status of the patients.

		Male		Female		P-Value
		Mean	SD	Mean	SD	
SVBW	C3	24.8616	2.9497	24.5996	2.57694	0.357

	C4	24.3506	4.31687	23.7899	3.99433	0.039
	C5	24.3894	3.6972	23.8186	3.92879	0.045
	C6	24.5772	2.81705	24.4599	3.06207	0.157
	C7	24.5029	3.99487	25.2028	3.99331	0.044
SVBI	C3	16.0131	1.71317	16.1778	1.76928	0.041
	C4	23.1773	3.71049	22.9893	3.80257	0.032
	C5	18.5632	4.35269	18.465	4.28134	0.141
	C6	16.4981	2.20194	16.2892	1.6463	0.081
	C7	23.66	3.84563	23.8126	3.56664	0.349
IVBW	C3	23.6535	3.83812	23.5474	3.54926	0.678
	C4	17.2291	3.46339	16.6325	3.01726	0.042
	C5	24.3442	2.40158	23.2139	2.49136	0.048
	C6	24.1803	3.69804	24.0395	2.91481	0.66
	C7	24.8527	3.12251	24.4002	2.96149	0.136
IVBL	C3	17.3782	3.2166	17.4989	3.39573	0.714
	C4	16.276	2.05395	16.038	2.00909	0.242
	C5	16.2122	1.90202	16.1249	1.94994	0.65
	C6	16.4185	2.17403	16.3218	1.92911	0.315
	C7	16.3227	2.08988	16.2701	2.04597	0.799
AVBH	C3	16.0151	1.82038	16.0087	2.02676	0.973
	C4	16.5286	2.31036	16.4627	2.24927	0.775
	C5	16.453	1.95022	16.5507	2.08297	0.625
	C6	16.3581	2.19147	15.9776	1.86619	0.046
	C7	16.325	1.96658	16.0917	2.00049	0.24
PVBH	C3	16.9625	2.06197	16.413	1.89347	0.007
	C4	16.1388	1.92247	16.2028	2.022	0.005
	C5	15.9289	2.08374	16.2603	1.92295	0.096
	C6	16.1516	1.88382	16.218	2.03697	0.732
	C7	15.9498	2.08652	15.664	1.72002	0.124
SVFW	C3	22.1002	4.17171	21.714	4.39742	0.365
	C4	23.4818	3.15124	23.9769	3.10845	0.115

	C5	24.6895	2.75059	24.4248	2.75849	0.339
	C6	25.1791	2.91625	25.2609	3.12054	0.004
	C7	23.3369	3.60052	24.3241	3.05525	0.003
SVFL	C3	16.3188	2.15631	16.341	2.26182	0.919
	C4	16.3924	2.23626	16.3559	2.09107	0.868
	C5	16.542	2.46816	16.4618	2.16984	0.725
	C6	18.5969	4.82446	18.8041	4.7005	0.666
	C7	16.6867	2.64283	16.4153	2.47955	0.297

The results showed that C5 and C6 vertebrae in superior vertebral body wider, C3 and C4 vertebrae in inferior vertebral body length and C5 vertebra in posterior vertebral body high had significant differences among different heights ($p<0.01$) and the mean of these vertebrae (in terms of height, width and length) were higher and wider in heights over 180 meters than shorter heights (**Table 3**).

Table 3: Determining the relationship between age and morphological status in the study population.

		20-39		**40-59**		**>60**		**P-Value**
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	
SVBW	C3	24.9578	2.7813	24.8922	2.37452	25.2875	3.48218	0.013
	C4	24.0981	3.95989	24.8448	4.20766	24.89	4.60183	0.121
	C5	23.9445	3.32346	24.398	4.1076	24.3175	3.95891	0.044
	C6	24.6091	2.81778	24.5871	2.95843	24.3446	2.9471	0.514
	C7	24.6519	3.85568	24.3771	3.97054	25.4323	4.24016	0.154
SVBI	C3	16.1659	1.82506	16.0538	1.79591	17.9248	1.45034	0.008
	C4	22.9306	3.64813	23.4009	3.55085	24.9702	4.15938	0.045
	C5	18.5613	4.28511	18.5992	4.25858	18.3724	4.52774	0.512
	C6	16.3723	1.86848	16.4226	2.28391	16.5349	1.89817	0.165
	C7	23.5366	4.14917	23.9604	3.43305	23.6018	3.55326	0.194
IVBW	C3	23.6461	3.63879	23.8166	3.73816	23.2592	3.92282	0.376
	C4	16.9704	3.23895	17.1508	3.6586	16.9496	2.9425	0.044
	C5	24.3102	2.49086	24.3438	2.56067	24.2192	2.11189	0.737
	C6	24.1574	3.36115	23.9022	3.38731	24.4625	3.72058	0.646
	C7	24.8228	3.06184	24.7296	2.88485	24.4656	3.38807	0.26
IVBL	C3	17.5734	3.24825	17.227	3.3436	17.4623	3.21716	0.297

	C4	16.2015	1.89224	16.1616	2.13378	16.2487	2.14112	0.916
	C5	16.1817	2.01072	16.1251	1.82517	16.279	1.91045	0.827
	C6	16.157	2.22388	16.1946	2.10215	16.2178	1.87736	0.866
	C7	16.3444	2.15302	16.2637	1.93405	16.3066	2.16865	0.887
AVBH	C3	16.0585	1.97443	16.1002	1.94768	15.7992	1.63033	0.385
	C4	16.5688	2.38909	16.595	2.25281	16.2645	2.17386	0.605
	C5	16.3903	1.95732	16.4222	1.93361	16.7424	2.13691	0.32
	C6	16.234	2.0245	16.1482	2.21263	16.3658	2.03302	0.757
	C7	16.3579	2.10254	16.1769	1.96361	16.1792	1.79094	0.441
PVBH	C3	16.833	2.02071	16.7012	1.97453	16.8245	2.11433	0.662
	C4	16.2838	2.21162	16.1964	1.6804	15.896	1.89242	0.035
	C5	16.2648	2.15927	15.9527	2.00589	15.7962	1.84409	0.032
	C6	16.0705	2.00453	16.1161	1.73521	16.4353	2.0996	0.212
	C7	15.945	2.02495	15.9178	2.11107	15.6093	1.64204	0.404
SVFW	C3	21.6766	4.39474	22.1011	4.47745	22.2629	3.57343	0.441
	C4	23.8811	3.12199	23.4257	3.16175	23.599	3.14793	0.344
	C5	24.6841	2.53529	24.6364	2.90736	24.4129	2.86388	0.783
	C6	25.4274	2.98089	25.2224	3.07409	24.8125	2.81784	0.0016
	C7	23.5889	3.60072	23.7179	3.53287	23.693	3.11098	0.636
SVFL	C3	16.509	2.34692	16.1004	1.93516	16.3801	2.28365	0.015
	C4	16.303	2.06866	16.4196	2.15913	16.4467	2.42793	0.812
	C5	16.6835	2.39945	16.4665	2.24254	16.3146	2.52484	0.471
	C6	18.5932	4.67946	18.7938	4.8086	18.5804	4.93781	0.663
	C7	16.6397	2.68229	16.5452	2.58032	16.61	2.4721	0.602

The results indicated that the vertebrae C3, C4 and C5 in the superior vertebral body width, the vertebra C3 in the superior vertebral body length, the vertebra C3 in the inferior vertebral body width, the vertebra C7 in the inferior vertebral body length, the vertebra C6 in the anterior vertebral body height and the vertebrae C6 and C7 in the posterior vertebral body height had significant differences in different BMI groups ($p<0.01$) and that the mean of these vertebrae (in terms of height, width and length) were higher and wider in people with higher BMI than in people with lower and medium BMI (**Table 4**).

Table 4: Determining the relationship between height and morphological status in the study population.

		140-159		160-179		>180		P-Value
		Mean	SD	Mean	SD	Mean	SD	
SVBW	C3	24.6212	2.32118	24.7308	2.70148	24.9031	3.19541	0.699
	C4	24.4965	3.99597	24.7683	4.38223	24.0362	3.97929	0.597
	C5	23.4802	3.80841	24.4206	3.75398	24.0813	3.80338	0.001
	C6	24.2422	2.4902	24.5533	3.05162	24.6154	2.76817	0.045
	C7	24.5939	3.65581	24.8147	4.08318	24.6438	4.00416	0.808
SVBI	C3	16.4455	1.87576	16.0693	1.80095	15.9344	1.54399	0.065
	C4	22.6445	3.99887	23.1386	3.63145	23.238	3.83464	0.961
	C5	18.4899	3.93297	18.4318	4.17407	18.7113	4.707	0.141
	C6	16.4135	1.80012	16.4247	1.85876	16.4428	2.38208	0.081
	C7	24.4506	3.18943	23.6578	3.74121	23.5446	3.93976	0.065
IVBW	C3	23.4131	3.12487	23.4443	3.90712	23.9814	3.64678	0.084
	C4	16.5947	3.03186	17.0692	3.3908	17.1218	3.33931	0.998
	C5	24.8573	1.67473	24.2117	2.5998	24.2613	2.33786	0.652
	C6	24.12	3.42944	23.901	3.2928	24.5297	3.71489	0.664
	C7	24.3308	2.73402	24.6166	3.12621	24.978	3.09412	0.923
IVBL	C3	17.9324	3.08465	17.5675	3.51761	18.9908	2.85666	0.011
	C4	15.9312	1.95321	16.2262	2.00781	16.2413	2.12794	0.041
	C5	15.7143	1.84827	16.191	2.00019	16.3314	1.77658	0.598
	C6	16.2849	2.17299	16.2329	1.96685	16.0715	2.28309	0.572
	C7	16.0725	1.82491	16.287	2.10937	16.4159	2.09755	0.964
AVBH	C3	15.9433	1.61703	15.9415	1.80716	16.1568	2.10011	0.701
	C4	16.2451	1.94836	16.742	2.4849	16.2021	2.00058	0.492
	C5	16.8651	2.22989	16.382	2.00612	16.5281	1.87901	0.523
	C6	16.048	1.66567	16.2182	2.05778	16.3212	2.28957	0.92
	C7	16.3702	2.3269	16.1878	2.04476	16.308	1.73163	0.536
PVBH	C3	16.0496	1.845	16.6671	1.87081	17.2248	2.22886	0.162
	C4	16.6631	2.54207	16.114	1.79827	16.0646	1.9638	0.151
	C5	16.5973	2.21034	15.882	1.79856	16.108	2.30877	0.01
	C6	15.8665	1.48358	16.3222	2.11414	16.0289	1.7284	0.262
	C7	15.4776	1.70751	15.8453	2.0115	16.0028	1.99597	0.068

SVFW	C3	22.6367	3.95748	21.8986	4.29483	21.8713	4.26673	0.243
	C4	24.0373	2.55141	23.7126	3.07908	23.3962	3.4183	0.906
	C5	24.2076	3.03877	24.8101	2.52745	24.3891	2.99209	0.54
	C6	25.4598	2.75397	25.2116	3.02822	25.1097	2.99179	0.724
	C7	24.3786	3.88926	23.7116	3.24095	23.3321	3.63567	0.271
SVFL	C3	16.5712	2.36062	16.3359	2.08468	16.2257	2.30494	0.156
	C4	16.4812	1.81784	16.3986	2.21348	16.3153	2.26866	0.72
	C5	16.2986	1.96204	16.456	2.47549	16.6898	2.32526	0.852
	C6	19.3696	4.80868	18.5692	4.79817	18.5848	4.75105	0.462
	C7	16.2675	2.49084	16.5418	2.45051	16.8037	2.8419	0.39

Discussion

In this study, we examined the morphological status of the cervical spine (C3-C7) in patients referred to Taleghani Hospital in Kermanshah with a sample size of 450 patients. The results of this study showed that the mean of these vertebrae (in terms of height, width and length) were higher and wider in men than in women, which is consistent with the results of the studies by Ezra et al. that aimed to "investigate the demographic aspects of the size and shape of the cervical vertebrae body (C3-C7)" that were conducted in 2017 and 2019 and showed that the shape and size of the cervical vertebrae body had a significant statistical relationship with gender, such that the size of the vertebrae body in men was significantly larger than in women. The results of this study are also in line with the study by Been, Shefi and Soudack that aimed to determine the role of gender in creating cervical spine lordosis, based on the need of considering the patient's gender by physicians before performing neck stabilization or repair procedures. Another study that is consistent with our study is the study by Rozendaal et al. entitled "Estimating the effect of gender on the morphology of the seven cervical vertebrae: analysis of two European populations" that showed that the variables of maximum vertebrae body height (CHT) and transverse foramen diameter (CTR) had a significant statistical relationship with the patients' gender [7].

Another study that is consistent with our research is the study by Fahimeh Keyvanloo, Mohammad Seyed Ahmadi and Akbar Pejhan entitled "Radiographic components of forward head posture and its relationship with gender and height". In this descriptive-analytical study, 300 students from Razi University of Kermanshah were randomly selected from both boys and girls and evaluated and screened using the Posture Pro V (PPV) software. Those who had the most severe Forward Head Posture (FHP) (5<FHP) were chosen as the subjects with forward head posture and those who had the lowest FHP (FHP<5) were chosen as the healthy subjects for comparison and agreed to participate in the next stages of the test. The forward head translation (AHT), cervical lordosis (C2-C7) and upper cervical curve (C1-C2) of them were assessed in the lateral radiograph. Independent t-test was used to compare the means of the two groups of healthy and with FHP and Pearson correlation was used to examine the relationship of the variables with a significance level (P<0.05). SPSS software version 16 was used for statistical analysis. The findings show that the cervical lordosis of the forward head subjects (C2-C7=23.44 ± 6.26) was significantly (P=0.0001) lower than the healthy subjects (C2-C7=38.29 ± 5.24). Short people and women had more severe forward head posture (25.67 *vs.* 11.31) and lower cervical lordosis (23.11 *vs.* 33.77) than tall people and men (P<0.01). They also found that the forward head posture caused a reduction in the natural lordosis of the neck and the emergence of kyphosis of the neck and in case of severe forward head posture, an S-shaped curve that resulted from the decrease in the lower curve of the cervical vertebrae (C2-C7) and the increase in the upper curve of the cervical vertebrae (C1-C2) might be formed. According to the final result of this research, forward head posture causes a reduction in the natural lordosis of the neck and the creation of kyphosis of the neck and increasing height does not cause an increase in the forward head posture but women have more severe forward head posture than men [8]. Which is in agreement with our research in terms of the effect of gender on the morphological status of the cervical spine.

Another study that is in line with our research is the study by Farzaneh Moslemi Haghighi, Mohammad Reza Fotouhi Abadi and Ali Ghanbari entitled "Investigating the prevalence of head forward position and its relationship with various variables in high school students of Shiraz city". In this descriptive-sectional study, 240 female and 240 male high school students of Shiraz city were randomly selected by systematic cluster sampling and the relationship between head forward position and variables such as gender, study position, visual impairment and exercise was examined. First, the necessary information from each sample was recorded in the questionnaire and then the head forward position of the samples was checked and recorded by the plumb line. The results of the study showed that the

prevalence of head forward position from the left and right sides was 76.1% and 74.6%, respectively, and there was a significant difference between head forward position and gender, study position and exercise ($p<0.05$), but no significant difference was seen for visual impairment. In this study, the relationship between gender and the morphological status of the cervical spine was confirmed, which is consistent with our study.

Another study that was conducted by Hasan Daneshmandi, Hossein Pour Hosseini and Mohammad Ali Sardar entitled "Comparative study of spinal abnormalities in male and female students" involved 616 middle school students as the research sample, including 300 girls and 316 boys with an age range of 15-12 who voluntarily participated in the study and the sampling method was random and cluster. The most important results of this research are that 79.75 percent of boys and 81.66 percent of girls and in general 80.68 percent of the research population have spinal posture abnormalities. The results of the study showed that there was a significant difference between the spinal status of boys and girls ($P<0.01$) and in general, in the assessment of the spinal status of the subjects, it was observed that the prevalence rate of most abnormalities in girls was higher than boys. Which is in agreement with the result of our research.

The results of this study showed that the average of these vertebrae (in terms of height, width and length) were higher and wider in ages above 60 years than lower ages, which is consistent with the results of the study by Ezra et al. that was conducted in 2017 and 2019 that showed that with the increase of the patients' age, the shape changes of the cervical vertebrae became more elongated, wider and shorter. The results obtained with the aim of determining the relationship between age and morphological status in the current study population showed that the vertebrae C3 and C5 in superior vertebral body wider, the vertebrae C3 and C4 in superior vertebral body length, the vertebra C4 in inferior vertebral body wider, the vertebrae C4 and C5 in posterior vertebral body high, the vertebra C6 in superior vertebral foramina wider and the vertebra C3 in superior vertebral foramina length had significant differences in different ages; meaning that the average of these vertebrae (in terms of height, width and length) were higher and wider in ages above 60 years than lower ages.

Ezra et al. in 2019 in a study entitled "Investigating osteophytes in the cervical vertebrae body (C3-C7) from the perspective of demographic characteristics" based on the findings of CT-scan of the cervical spine (C3-C7) of 273 patients examined them in terms of age. The findings obtained from this study showed that the prevalence of osteophytes was only related to age in the upper cervical vertebrae (C3-C4), which is also the result of our research. In another study with the aim of determining the anatomical characteristics of the cervical spine based on age, which was done by Parenteau et al. in 2015; the researchers examined the findings of CT-scan of 750 patients, 314 of whom were children and 436 of them were adults, in line with their research objectives. The findings from this study showed that the height of the vertebrae body had a positive non-linear and statistically significant relationship with the patients' age, which is also a result that supports the results obtained from our research [9].

Another study that was done by Ali Asghar Nourasteh and Hamid Zolqadr with the aim of "investigating the effect of age on the alignment and range of motion of the cervical spine" from 1999 to 2020, this study was a comprehensive review of the effect of age on the alignment and range of motion of the cervical spine through searching in Google Scholar, PubMed and Scincedirect databases with keywords cervical spine, neck, range of motion, cervical alignment, cervical angle and age-related change and also Persian databases Google Scholar, Magapaper, Irandoc, Magiran, Scientific Information Center of Jihad University, Medlib, Iran Medex and Iran Science and Technology Institute with keywords neck, cervical spine, range of motion, cervical alignment, cervical angle and age-related change and after reading the abstracts of the articles and matching them with the study criteria, we finally chose 37 articles for the study. These studies mainly studied the effect of age on the range of motion and cervical alignment in healthy individuals. According to the results of the studies, with the increase of age, the range of motion in the cervical spine decreases, which does not follow a regular pattern, because it increases in some ages and decreases in some ages. The result of the study also showed that the increase of age not only affects the range of motion but also affects the cervical spine alignment [10].

The results showed that the average of these vertebrae (in terms of height, width and length) were higher and wider in heights above 180 meters than shorter heights. In the study of the relationship between height and morphological status, the results showed that the vertebrae C5 and C6 in superior vertebral body wider, the vertebrae C3 and C4 in inferior vertebral body length and the vertebra C5 in posterior vertebral body high had significant differences in different heights; meaning that the average of these vertebrae (in terms of height, width and length) were higher and wider in heights above 180 meters than shorter heights. In a study entitled "Investigating the changes of cervical lordosis and cervico-vertebral morphology in different ages" that was done in 2015; Lazić et al. examined 120 patients in 3 age groups of 8, 13-12 and 18-17 years in line with their research objectives. The researchers concluded that there was a significant statistical relationship between the angle of cervical lordosis and the anterior and posterior height of the vertebrae body (AVBH and PVBH) of the vertebrae C3, C4 and C5, the anterior intervertebral space of C4-C5 and the posterior of C2-C3, C3-C4 and C4-C5.

Another study that was done by Gholamhossein Saljooghi and Behnam Mirzaei with the aim of "investigating the recognition of abnormalities in 11 to 13 year old male students and their relationship to three factors of age, weight and height" was conducted on 1688, 11 to 13 year old male students of Karaj city with an average height of 152 ± 0.68 meters and an average weight of 2.49 ± 7.48 kilograms. In this study, first, using a digital camera, each of the subjects was photographed from three views (anterior-posterior-lateral) and then, using the corrective movements software, the abnormalities of these students were evaluated and recorded. The findings showed that: There was a significant relationship between the age factor and the

abnormalities of head forward, kyphosis, scoliosis and pelvic drop and there was a significant relationship between the height factor and the abnormalities of head forward, kyphosis, scoliosis, knee valgus and pelvic drop. Therefore, it can be concluded that the occurrence of these abnormalities is related to factors such as age and height.

Conclusion

Both conclusions are consistent with the results of our research. The results of this study indicated that the average of these vertebrae (in terms of height, width and length) were higher and wider in people with higher BMI than people with medium and low BMI. In the study of the relationship between BMI and morphological status of the cervical spine, the results showed that the vertebrae C3, C4 and C5 in superior vertebral body wider, the vertebra C3 in superior vertebral body length, the vertebra C3 in inferior vertebral body wider, the vertebra C7 in inferior vertebral body length, the vertebra C6 in anterior vertebral body high and the vertebra C6 and C7 in posterior vertebral body high had significant differences in different BMI; meaning that the average of these vertebrae (in terms of height, width and length) were higher and wider in people with higher BMI than people with medium and low BMI. These results were consistent with the results of the study by Mohammad Rahimi, Faezeh Shah Mohammadi and Amaneh Ghasemi that was entitled "Investigating the prevalence of musculoskeletal disorders in workers of Yutab factory and its relationship with posture during work, work history and body mass index" that was done on 60 workers of Yutab factory based on the entry and exit criteria. Musculoskeletal disorders were evaluated and analyzed by using the Nordic questionnaire and work history by questionnaire and posture during work by REBA test. Body mass index of workers was also obtained by using a scale and a height meter and using the formula (weight (kg)/height $(m)^2$). Spearman correlation test showed a significant relationship between all variables of posture during work, work history and body mass index with the most common musculoskeletal disorders.

According to the results obtained in this study and comparing them with the results obtained in the researches with the same objectives as our study, it was determined that in terms of morphology (length, width and height) of the cervical spine (C3-C7) in men, people over 60 years old, height more than 180 centimeters and high BMI; they were higher and wider.

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