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The Impact of Body Mass Index Values on the Quality of Cardiopulmonary Resuscitation: A Manikin Study

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ABSTRACT

Objective: The purpose of this study is to assess the impact of body mass index (BMI) on the quality of cardiopulmonary resuscitation (CPR) by using a manikin.

Methods: 50 people composed of research assistants, intern doctors, emergency medical technicians and nurses who had previous cardiopulmonary resuscitation experience performed CPR on Laerdal Skillmeter Resusci-Anne® with SimPad manikin during the study. BMI data of participants were recorded and then the participanst were categorised as BMI <21 and BMI >21. Compression data obtained from the summary section of SimPAD QCPR were compared with the participants BMI values.

Results: 18 (36%) out of 50 participants were male, while 32 (64%) were female. 16 (32%) out of 50 participants were in the slim group, while 34 (68%) were in the normal group. Mean age of participants was calculated as 26.8±4.2, and mean BMI as 22.56±3.32. Mean compression depth in the slim group was significantly lower in comparison to the normal group (slim51.94±4.64, normal 55.79±4.35, p=0.006). Compression ratiowith sufficient depth in the slim group was statistically lower than the normal group (slim 66.19±25.79, normal 87.29±19.36, p=0.002). A statistically significant positive correlation was found in the lineer regression analysis conducted between mean compression depth and BMI (r2:0.179, p=0.002). Moreover, a significant positive correlation was observed in the pearson correlation analysis of mean compression depth and BMI (r: 0.423, p= 0.002).

Conclusion: As a result, it was found out that low BMI values are associated with low mean compression depth.

Keywords: Body Mass Index, cardiopulmonary resuscitation, basic cardiac life support.

1. INTRODUCTION

The prognosis of out-of hospital cardiac arrest (OHCA) is bad (1). Annually, itresults in300,000 people's death (2). The most important method to reduce this mortality is to increase the quality of cardiopulmonary resuscitation (CPR). It is know that simple changes such assufficient compression rate, sufficient compression depth, compression allowing for chest recoil, minimising compression interruptions and avoiding exteme ventilation increase survival rates by increasing CPR quality (3-5).

It has been stressed out that anthropometric variables have an impact on CPR quality (6). There are studies on the fact that anthropometric parameters affecting CPR include body weight, height, physical fitness and muscle power (7-9).

Our purpose is to compare data that could have an impact on CPR quality based on Body Mass Index (BMI) parameter by using a manikin.

2. METHODS

On June 5, 2020 this prospective simulation manikin study had an ethics committee approval by Necmettin Erbakan University Meram Medical Faculty Pharmaceutical and Non-Medical Device Studies Ethical Committee by the decision number of 2020/2570.

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50 people composed of different professional groups working at our clinic (research assistants, intern doctors, emergency medical technicians and nurses) that have previous cardiopulmonary resuscitation experience, are knowledgeable about advanced cardiac life support and basic life support were randomly selected for the study on

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a voluntary basis. The participants signed a letter of consent for the study.

Laerdal Skillmeter Resusci-Anne® with SimPad manikin was used in the study. The participants were asked to perform non-stop compressionfor 2 minutes on the manikin. The manikin was introduced to the participants prior to compression. It was ensured that they had the sufficient time to perform CPR on the manikin. The manikin was planned to lie flat on its back on the ground during compression (supine position).

A metronom was used during compression to minimise the impact of compression rates on chest recoil (10). The metronom was arranged in a way to provide voice prompts 110 times per minute to achieve a rate of 100–120 compressions per minute as stated by the American Heart Association (AHA) and the European Resuscitation Council (ERC) guidelines (11,12).

The data of CPR (after 2 minutes of compression) on the manikin were automatically generated by the summary section of SimPAD QCPR. Mean compression depth (mm), mean compression rate (compression/minute), compression ratio with a complete chest recoil (%), compression ratio with sufficient depth (%), compression ratio with sufficient rate(%) values were obtained from the summary section of SimPAD QCPR. The manufacturing company defined that the sufficient depth was between 50 and 60 (mm) in reference to AHA and ERC guidelines. The manufacturing company defined sufficient rate was between 100 and 120 (compression/ minute) in reference to AHA and ERC guidelines. In addition, age, gender, profession, body mass index information of the participants were also recorded.

Though those below 20 are considered slim in BMI calculations (13), our study categorised BMI values as below and above 21. The group with BMI<21 was categorized as slim, while the group with BMI≥21 was categorized as normal. The reason we categorized it in this way was to reach a sufficient number of group populations to make statistical comparison. In addition, the participants were divided into 3 groups according to the cut-off BMI values of 21 and 23 (BMI<21, 21≤BMI<23 and BMI≥23).

The compression values on the manikin were compared between the groups. SPSS 20.0 (SPSS Inc., Chicago, IL) package was used to perform such a comparison and analyse the data statistically. Analyses of normality of the data were made by using histograms and Kolmogorov–Smirnov test.Non-normally distributed quantitative data were stated as median (25%-75% quarters), while normally distributed quantitative variables were stated as mean±standard deviation (SD), and categorical variables were stated as frequency (percentage) [n (%)]. The differences between two groups were investigated using the Mann–Whitney U test in non-normally distributed quantitative variables, while Student's t-test was used for normally distributed quantitative variables. The differences between more than two groups were investigated using the Kruskal-Wallis test in non-normally distributed quantitative variables, while one-way Anova test was used for normally distributed quantitative variables. Dunnett's T3 test was used as a post hoc analysis test for non-normally distributed quantitative variables while Bonferroni test was used as a post hoc analysis test for normally distributed quantitative variables. We used the Bonferroni correction for multiple comparisons. Pearson correlation analysis and linear regression analysis were performed to assess the relationship between mean depth and BMI. p <0.05 value was accepted as statistically significant.

3. RESULTS

18 (36%) out of 50 participants were male, while 32 (64%) were female. 18 (36%) of the participants were assisstant doctors, 21 (42%) were intern doctors, 10 (20%) were nurses and 1 (2%) was emergency medical technician (EMT). Mean±SD age of the participants was 26.8±4.2, while mean±SD BMI was found to be 22.56±3.32.

Sixteen (16 (32%)) of the participants were in the slim group and 34 (68%) were in the normal group. Mean compression depth values in the slim group were significantly lower than the normal group (slim 51.94±4.64, normal 55.79±4.35, p=0.006). Compression ratio with sufficient depth in the slim group was statistically significantly lower in comparison to the normal group (slim 66.19±25.79, normal 87.29±19.36, p=0.002). Detailed information about compression data and comparison in between the groups (the cut-off BMI value of 21) are available in Table 1.

Table 1. *Results of compression data between the groups*

	Slim (mean±SD)	Normal (mean±SD)	p value
Mean Compression Depth(mm)	51.94±4.64	55.79±4.35	0.006
Mean Compression Rate (compression/minutes)	111.63±1.66	112±3.03	0.647
Compression Ratio with Complete Chest Recoil (%)	85±14.63	80.74±17.68	0.406
Compression Ratio with Sufficient Depth (%)	66.19±25.79	87.29±19.36	0.002
Compression Ratio with Sufficient Rate (%)	94.75±6.12	92.74±10.41	0.478

SD: Standard deviation

The number of participants with BMI<21 was 16 (32%), the number of participants with 21≤BMI<23 was 17 (34%) and the number of participants with BKI≥23 was 17 (34%). Mean compression depth of the BMI≥23 was statistically higher than that of the BMI<21 (BMI≥23: 57.94±2.74, BMI<21: 51.94±4.64, p<0.001). Mean compression depth of the BMI≥23 was statistically higher than the 21≤BMI<23 (BMI≥23: 57.94±2.74, 21≤BMI<23: 53.65±4.66, p=0.011). Compression ratio with sufficient depth of the BMI≥23 was statistically higher than that of the BMI<21 (BMI≥23: 96.41±6.73, BMI<21: 66.19±25.79, p<0.001). Detailed information about compression data and comparison in between the groups (the cut-off BMI values of 21 and 23) are available in Table 2.

Linear regression analysis of mean compression depth (dependant) and BMI (independent) showed a statistically significant (r^2=0.179) positive relationship (p=0.002). 'Expected mean compression depth=40.893+0.606*BMI' in line with the calculated regression formula. Moreover, a significant positive correlation was observed between mean compression depth and BMI in the Pearson's correlation analysis (r=0.423, p=0.002).

Table 2. *Results of compression data between the groups (the cut-off BMI values of 21 and 23)*

	BMI<21 (mean±SD)	21≤BMI<23 (mean±SD)	BMI≥23 (mean±SD)	p value	p (I-II)*	p (I-III)**	p (II-III)***
Mean Compression Depth(mm)	51.94±4.64	53.65±4.66	57.94±2.74	<0.001	0.713	<0.001	0.011
Mean Compression Rate(compression/minutes)	111.63±1.66	112.06±3.5	111.94±2.58	0.894	0.999	0.999	0.999
Compression Ratio with Complete Chest Recoil (%)	85±14.63	81.29±18.17	80.18±17.71	0.698	0.999	0.999	0.999
Compression Ratio with Sufficient Depth (%)	66.19±25.79	78.18±23.48	96.41±6.73	<0.001	0.294	<0.001	0.037
Compression Ratio with Sufficient Rate (%)	94.75±6.12	92.24±11.39	93.24±9.66	0.743	0.999	0.999	0.999

*SD: standard deviation; *: p values are obtained from the paired comparisons of parameters of BMI<21 and 21≤BMI<23 groups; **: p values are obtained from the paired comparisons of parameters of BMI<21 and BMI≥23 groups; ***: p values are obtained from the paired comparisons of parameters of 21≤BMI<23 and BMI≥23 groups*

4. DISCUSSION

We have to take the necessary measures to perform quality cardiopulmonary resuscitation. Anthropometric variables are among one of the factors that will have an impact on CPR's quality. We compared compression data that will affect CPR quality with BMI values in our study.

Mean depth and compression with sufficient depth ratios were significantly lower in the slim group with BMI values below 21 in comparison to the other group. In their manikin study involving 102 nursing students, Roh et al. pointed out that mean depth measurements of the group with BMI values below 18.5 were significantly lower than the other groups (14). The data of the study are compatible with the literature.

Linear regression analysis indicated a significant positive correlation between BMI and mean compression depth data. At the CPR study conducted by Oh et al. with 107 medical students on a manikin, a positive correlation was found between body weight and mean compression depth (15). Regression equation in the same study revealed that rescuers should weigh minimum 70.5 kg to achieve a chest compression depth of 50 mm. The data of the study are compatible with the literature.

A significant positive correlation was observed between BMI and mean depth in our study. The highest positive correlation was found between mean depth and body weight in the correlation analysis of anthropometric variables and CPR data in the CPR study by Oh et al. conducted with 107 medical students on a manikin (15). The same study showed a significant positive correlation between BMI and mean depth. Similarly, the study of Méndez-Martínez et al. including 112 nursing and physiotherapy students found out a significant positive relationship between BMI and weight (16). The data of the study are compatible with the literature.

The study by Contri et al. where 333 participants performed CPR on a manikin indicated that people who are heavier, who have a greater BMI achieve less chest recoil (6). In our study, chest recoil ratio was found out to be higher in the slim BMI group but the difference in between was not statistically significant. The importance of achieving higher chest recoil decreases due to lack of sufficient depth.

5. CONCLUSION

As a conclusion, it was found out that low BMI values are associated with low mean compression depth. Effective trainings to achieve sufficient mean depth should be provided as out-of-hospital arrest patients for whom a low mean depth CPR is performed, have a higher mortality (17,18). However, it is observed that low weighing individuals could not achieve the sufficient chest compression depth though they have participated in effective CPR trainings (19). Therefore, we should be more careful and sensitive when we provide CPR trainings to low weighing professionals (14,19). We are in the opinion that we should be more sensitive in terms of CPR training of professionals with low BMI values and besides, professionals with higher BMI values should be responsible for compression during CPR as long as there is a sufficient number of professionals to do so.

The limitation of the study could be considered as the low number of participants. The low number of participants especially in the slim group constitutes another limitation as it reduces the power of statistical comparison. The factors such as being a manikin study, failure to evaluate the survival rates can be considered as another limitations of our study. A separate limitation is that compression data cannot be compared according to gender. Because male gender with low BMI values may be different from female.

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