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Comparison of cardiopulmonary resuscitation skills of physically active and inactive university students

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Abstract

Sudden cardiac arrest is one of the life threatening conditions, and if not treated immediately and effectively death will occur within minutes. Cardiopulmonary resuscitation (CPR) is the most effective way to save lives of cardiac arrest patients. Studies showed a correlation between physical fitness and quality of CPR. The aim of this study is to compare the CPR skills of female and male physically active (PA) and physically inactive (PIA) undergraduate students. Of the 120 undergraduate students, 37.5% were physically active and 62.5% were physically inactive. The participants' mean age was 21.40±2.02 years. In order to identify physically active and physically inactive students, they were asked about their physical activity participation. Data on students' CPR performance were collected via Laerdal Resusci Anne SkillReporter™ manikin. During the data collection (after training), each student was instructed to perform 10 sets of CPR in an isolated laboratory environment. Training included standard CPR content for the all the participants. The results of this study showed that the physically active participants performed better CPR ventilation and compression skills than physically inactive participants did. Physically active female and male participants achieved a higher mean percentage of correct ventilations and chest compressions. In conclusion, the findings suggest that physical activity positively correlated with CPR quality.

Keywords: Physical education, PE major, physical activity, first aid, CPR

INTRODUCTION

The Physical Education (PE) Teacher Education Program in Turkey consists of various compulsory and elective courses. Health Education and First Aid course is one of these compulsory courses. The aim of this course is to provide PE teacher candidates with the necessary knowledge and skills to save lives of their students and all other individuals in the society (Council of Higher Education [CoHE], 2007).

Cardiopulmonary Resuscitation (CPR) is one of the most important and essential lifesaving first aid skills for patients with sudden cardiac arrest (abrupt loss of heart function) (Lloyd-Jones et al., 2010; McKenna & Glendon, 1985). Although the precise causes of cardiac arrest may vary, circulatory disorders are the leading cause of mortality and causing nearly 40% of the total annual deaths in Turkey (Turkish Statistical Institute [TUIK], 2013a). In addition, according to The AHA (2013) data, 382.800 cardiac arrest cases occurred in 2012 in The United States. Road traffic accidents also lead cause of death in Turkey, resulting in more than 1200.000 accidents and 3.500 deaths annually at the site of the accident (TUIK, 2013b). Natural disasters, such as earthquakes (26.973 earthquakes in 2012), are also potentially life threatening events (Disaster and Emergency Management Presidency [AFAD], 2013). Many examples may be cited, but it is well known that life-threatening conditions are mostly unexpected, and they can occur at any time and in any place. Delivery of effective CPR by well-equipped bystander is critical until ambulance service arrives to the scene (McKenna & Glendon, 1985; Nolan et al., 2010). It is, therefore, essential to increase the number of people who are trained in CPR in the society.

Since high quality CPR is directly related to the survival of the casualty, studies focused on the identification of possible factors that have positive and negative effects on CPR performance (Field et al., 2010). Rescuer's fatigue is stated to be one of the main causes of ineffective CPR, since it is reported as a primarily aerobic effort (Van Hoeyweghen et al., 1991). In addition, research findings have indicated that physical fitness is necessary to perform high quality CPR, especially during long periods of time (McKenna & Glendon, 1985; Lucia et al., 1999; Ock et al., 2011; Ochoa et al., 1998). Considering the long ambulance response time, physically capable first aiders may provide greater benefit to cardiac arrest patients (Zenginol et al., 2011; Pierce et al., 1992).

Studies have noted that physical education and sports majors participate in regular physical activity and sports and they have a good level of physical fitness (Bozkuş et al., 2013; Petersen et al., 2003). In addition, each physical education major candidate is required to pass Special Talent Exam that consists of different skill testing stations (Yaprak & Durgun, 2009). Furthermore, it was thought that the physically active participants, as being physical education majors, would already have one of the important elements of high quality CPR. Accordingly, this study aims to determine whether there are differences between physically active and inactive university students on the CPR skills.

METHOD

Subjects

Participants of the study were physically active (PA) physical education majors (n_{female}= 20, n_{male}= 25) and physically inactive (PIA) university students (n_{female}= 42, n_{male}= 33) taking First Aid as an elective course. The average age of participants was 21.40±2.02 ($\bar{x}_{female}$= 20.95±1.67, $\bar{x}_{male}$=21.87±2.25). Participants were asked to self-report their sex, age and perception of their own physical activity

condition (being a PA or PIA). All participants were informed about the study and were asked to voluntarily participate in the study.

Data Collection Procedures

Physically active group consisted of physical education teacher candidates taking compulsory Health Education and First Aid Course during their freshman level; the physically inactive group were 2nd year students (sophomores) enrolled in an elective undergraduate First Aid Course at the Department of Physical Education. Participants had similar task-related characteristics and had no previous knowledge and skill of CPR. Therefore, participants were not given any test to determine their CPR knowledge and skill level before training. The standard CPR, as a one of the units of these two courses, provided for physically active and inactive participants. The unit included both theoretical and hands-on practice sessions. On completion of the basic CPR unit, participants were tested individually for their CPR performance.

Within the context of the test, each participant required to perform the task alone in an isolated laboratory environment; and asked to perform 10 sets of CPR (1 set= 30 chest compressions, 2 ventilations). Data related to CPR skills were collected using a Laerdal Resusci Anne SkillReporter™ manikin. Manikin focuses on students' CPR performance through printed quantitative reports on ventilation (average volume of ventilations, number of correct ventilations, number of too much ventilations, etc.) and compression (average depth of compressions, number of correct compressions, number of too deep compressions, etc.) skills.

Data Analysis

A two-way between-groups analysis of variance was conducted to compare the interaction between sex of the participant and physical condition on the CPR ventilation and compression skills. The sex of the participants included two levels (female, male) and physical condition consisted of two levels (PA, PIA). Data were analyzed using SPSS version 16.0 software.

RESULTS

A two-way between-groups analysis of variance was conducted to explore the impact of sex (female, male) and groups (physically active, physically inactive) on ventilation skills. The main effects were ignored if the interaction effect was significant. There was a statistically significant interaction effect between the sex of the participants and the participants' physical condition on the number of correct ventilations [$F(1,116)= 5.58$, $p= .02$] (Table 1). Simple main effects analysis showed that both physically active female ($\bar{x}_{PA}= 11.7\pm4.41$) [$F(1, 116)= 26.36$, $p< .001$] and male participants ($\bar{x}_{PA}= 15\pm3.3$) [$F(1, 116)= 74.74$, $p< .001$] performed significantly more correct ventilations compared to physically inactive female ($\bar{x}_{PIA}= 5.9\pm4.3$) and male participants ($\bar{x}_{PIA}= 5.3\pm4.4$). Similarly, the statistically significant interaction effect was found between the sex of the participants and the participants' physical condition on the percent of correct ventilations [$F(1,116)= 6.2$, $p= .01$] (Table 1). The simple main effects analyses demonstrated that physically active female [$F(1, 116)= 19.71$, $p< .001$] ($\bar{x}_{PA}= 58.1\pm20.3$) and male participants [$F(1, 116)= 65.80$, $p< .001$] ($\bar{x}_{PA}= 73.0\pm14.5$) performed higher percentage of correct ventilations than physically inactive female ($\bar{x}_{PIA}= 33.2\pm23.2$) and male participants ($\bar{x}_{PIA}= 28.7\pm21.0$) (Table 1). In addition, analysis showed that the main effect of groups on number of too much [$F(1,116)= 12.94$, $p= .001$]; and too little ventilations [$F(1,116)= .95$, $p= .33$] was statistically significant. Participants in physically active group ($\bar{x}= 1.67\pm2.45$) performed fewer number of too little ventilations than participants in physically inactive group ($\bar{x}_{PIA}= 4.43\pm4.48$). No

interaction and main effects of sex and groups on average volume of ventilations, minute volume of ventilations, and number of too fast ventilations was found, $p>.05$.

Table 1. Means and standard deviations for the ventilation skills of participants

		Groups					
		Physically Active Group			Physically Inactive Group		
Ventilation skills	Sex	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
Average volume (ml)	Female	20	642.5	790	42	658.5	275.0
	Male	25	688.5	75.5	33	751.0	241.5
Minute volume (ml/min)	Female	20	2515.0	687.4	42	2417.6	1390.0
	Male	25	2655.2	437.6	33	3646.3	5246.7
Number correct (#) [a,c]	Female	20	11.7	4.41	42	5.9	4.3
	Male	25	15.0	3.3	33	5.3	4.4
Percent correct (%) [a,c]	Female	20	58.1	20.3	42	33.2	23.2
	Male	25	73.0	14.5	33	28.7	21.0
Too little (#) [a]	Female	20	3.00	3.06	42	4.65	4.50
	Male	25	.60	.96	33	4.15	4.50
Too much (#) [a]	Female	20	2.25	2.22	42	5.02	5.88
	Male	25	2.24	2.63	33	6.64	5.71
Too fast (#)	Female	20	4.40	4.44	42	3.81	5.50
	Male	25	3.72	1.97	33	6.24	6.49

[a] Groups main effect, [b] Sex main effect, [c] Groups X Sex interaction effect

A two-way ANOVA was conducted to explore the impact of sex and physical condition groups on chest compression skills; and the main effects were ignored if the interaction effect was significant. Analysis showed a significant interaction between the sex and physical condition of the participant on the average depth of the compressions [$F(1,116)= 5.69$, $p= .02$] and number of too shallow compressions [$F(1,116)= 4.36$, $p= .04$]. Simple main effects analysis showed that the difference between physically active and inactive female [$F(1, 116)= 66.57$, $p< .001$] and male participants [$F(1, 116)= 24.44$, $p< .001$]. Both physically active female ($\bar{x}= 52.25\pm2.88$) and male participants ($\bar{x}= 53.68\pm1.95$) performed closer to the required compression depth (at least 5 cm) compared to the physically inactive female ($\bar{x}= 34.86\pm9.37$) and male participants ($\bar{x}= 43.39\pm10.15$). Accordingly, simple main effects showed that the physical condition was significant for both female [$F(1, 116)= 104.49$, $p< .001$] and male participants [$F(1, 116)= 56.00$, $p< .001$]. Physically active female ($\bar{x}=50.05 \pm46.30$) and male participants ($\bar{x}= 23.68\pm17.79$) performed fewer number of shallow chest compressions compared to physically inactive female ($\bar{x}= 265.86\pm66.50$) and males ($\bar{x}= 177.88\pm121.30$). An analysis resulted in a significant main effect of physical condition on the number [$F(1,116)= 555.16$, $p= .00$] and percent of correct chest compressions [$F(1,116)= 581.85$, $p= .00$]; also analysis resulted in significant main effect of sex on a number [$F(1,116)= 14.43$, $p= .00$] and percent of correct chest compressions [$F(1,116)= 12.00$, $p= .00$]. Physically active female ($\bar{x}= 217.65\pm57.82$) and male participants ($\bar{x}= 259.84\pm35.47$) performed greater number of correct chest compressions compared to physically inactive female ($\bar{x}= 10.60\pm24.45$) and males ($\bar{x}= 37.61\pm68.24$); similarly physically active female ($\bar{x}= 71.80\pm17.36$) and male participants ($\bar{x}= 82.72\pm11.53$) performed greater percent of correct chest compressions compared to physically inactive female ($\bar{x}= 3.27\pm7.57$) and males ($\bar{x}= 12.30\pm21.97$).

Table 2. Means and standard deviations for the compression skills of participants

		Groups					
		Physically Active Group			Physically Inactive Group		
Compression skills	Sex	*N*	*Mean*	*SD*	*N*	*Mean*	*SD*
Average depth (mm) [a,b,c]	Female	20	52.25	2.88	42	34.86	9.37
	Male	25	53.68	1.95	33	43.39	10.15
Average number per min (#/min)	Female	20	64.60	15.46	42	71.52	15.71
	Male	25	65.72	10.37	33	87.55	110.91
Average compression rate (#/min)	Female	20	116.80	32.16	42	129.12	23.17
	Male	25	115.36	24.01	33	118.94	25.59
Total number (#) [b]	Female	20	291.35	51.57	42	294.71	38.43
	Male	25	313.44	24.33	33	302.45	23.70
Number correct (#) [a,b]	Female	20	217.65	57.82	42	10.60	24.45
	Male	25	259.84	35.47	33	37.61	68.24
Percent correct (%) [a,b]	Female	20	71.80	17.36	42	3.27	7.57
	Male	25	82.72	11.53	33	12.30	21.97
Too deep (#)	Female	20	0	0	42	0	0
	Male	25	0	0	33	0	0
Too shallow (#) [a,b,c]	Female	20	50.05	46.30	42	265.86	66.50
	Male	25	23.68	17.79	33	177.88	121.30

[a] Groups main effect, [b] Sex main effect, [c] Groups X Sex interaction effect

DISCUSSION

The aim of the study was to examine whether physically active female and male participants perform better CPR ventilation and compression skills than the physically inactive participants do. In line with the bystander CPR literature, findings from the current study are significant in that physically active participants performed better CPR ventilation and compression skills compared to physically inactive participants (Baubin et al., 1996; Berrones, 2010). These findings suggest that the physically active female and male individuals are more likely to perform high quality of CPR. Studies that have examined the association between physical activity and CPR have reported that physical exertion during implementation of CPR similar to the exertion during high intensity exercises (Badaki-Makun et al., 2013). In their preliminary work on the CPR and exercise relationship Van Hoeyweghen et al. (1991) investigated cardiovascular and ventilatory parameters during 40 min CPR, and concluded that CPR was a mainly aerobic effort. In an analysis of rescuers work capacity and CPR performance Baubin et al. (1996) have found that physical stress occurring during implementation of CPR is associated with the rescuer's work capacity. Their findings suggest that rescuer's work capacity and physical fitness should be improved by implementing regular aerobic exercises. In another study, Bridgewater et al. (2008) examined the ambulance crew's 10 min CPR performance and physical fitness level. The results of this study indicated that the implementation of 10 min CPR necessitates a superior physical effort, and 73% of the study participants described the test as being moderate- to vigorous-intensity and 27% being high-level intensity. A study conducted by Hansen et al. (2012) investigated whether physical fitness levels and chest compression performance of healthcare professionals are correlated. Their research identified ventilatory threshold as the important determinant of quality chest compressions for first 5 min, and maximal muscle strength for latter 5 min. Like other studies, their findings suggest that healthcare professionals, who give aid at emergencies and have a legal duty to give CPR, need to be physically well prepared to save lives of victims of cardiac arrest (Ock et al., 2011). Other researchers have found similar results for

relationship between rescuers' fitness level and CPR performance quality. A study of medical students experienced in CPR from Korea showed that muscle strength correlated significantly with quality chest compressions during 5 min chest compressions (Ock et al., 2011). Russo et al. (2011) showed that the higher levels of physical fitness and Body Mass Index are positively correlated with high quality chest compressions. The findings of the current study are also in agreement with Berrones's (2010) findings, which showed that aerobic fitness, and muscular endurance positively affects resuscitation efforts. There are also similarities between the better CPR ventilation and compression skills in the current study and those described by Lucia et al. (1999). Researchers compared the CPR performance of physically fit adults and healthcare professionals, and found no significant difference between their CPR performances. The evidence from their study Lucia et al. (1999) suggested CPR providers to participate in light to moderate aerobic exercise to perform CPR effectively.

Effective chest compression is one of the determinants of blood flow to vital organs during cardiac arrest (Rajab et al., 2011; Abella et al., 2005). European Resuscitation Council (ERC) guidelines for resuscitation recommend that CPR providers should implement at least 5 cm (but not exceeding 6 cm) deep chest compressions (Nolan et al., 2010). The findings observed in the present study showed both female and male physically active participants achieved the suggested compression depth of 5 cm; but physically inactive male and male participants performed compression depth below 5 cm. These results may be explained by the fact that physical activity positively affects chest compression quality. This finding is in agreement with Ock et al.'s (2011) findings, which showed the positive effects of physical fitness, especially muscular strength, on chest compression quality.

Although 2010 guidelines let first responders to apply chest compression only CPR, research evidence suggests that conventional CPR (combination of mouth-to-mouth ventilation and chest compression) more effective on survival rates of cardiac arrest patients, Therefore, the first responder plays key role in providing effective ventilations as well as chest compressions (Kitamura et al., 2010). The current study's findings related to ventilations revealed that both physically active female and male participants performed better ventilation skills compared to female and male physically inactive participants. Similarly, in their study Lucia et al. (1999) stressed the importance of physical fitness in the ventilation and chest compression skills for the survival of the cardiac arrest patients.

CONCLUSION

In conclusion, this study showed that physically active female and male participants performed CPR significantly better than physically inactive female and male participants did. This study revealed that, although it was unintentional, physical education and sports departments train their students as first responders who are successful and physically capable of saving lives of cardiac arrest patients. While physical education majors' actual level of physical activity (or level of physical fitness) was not measured, it could make a difference in terms of CPR performance. In agreement with previous studies, this study's findings strongly suggest a potential value in participating in regular physical activity and sports for individuals to achieve good quality CPR when needed. Future studies are needed to further investigate the association of CPR performance with different parameters of physical fitness.

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