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Review

Gender aspects in cardiopulmonary resuscitation by schoolchildren: A systematic review

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ABSTRACT

Aim: Bystander CPR-rates are embarrassingly low in some European countries. To increase bystander CPR-rates, many different approaches are used; one of them is training of schoolchildren in CPR. Multiple authors investigated practical and theoretical CPR performance and demonstrated gender differences related to schoolchildren CPR. The objective was to elaborate gender aspects in practical and theoretical CPR-performance from the current literature to better address female and male students.

Methods: A systematic search in PubMed-database with different search terms was performed for controlled and uncontrolled prospective investigations. Altogether, n = 2360 articles were identified and checked for aptitude. From n = 97 appropriated articles, n = 24 met the inclusion criteria and were finally included for full review and incorporated in the manuscript.

Results: Female students demonstrated higher motivation to attend CPR-training ($p < 0.001$), to respond to cardiac arrest (CA) ($p < 0.01$), scored higher in a CPR-questionnaire ($p < 0.025$), revealed better remembrance of the national emergency phone-number ($p < 0.05$) and showed a higher multiplier effect ($p < 0.0001$). Male students showed higher confidence in CPR-proficiency ($p < 0.05$), revealed deeper chest compressions (CC) ($p < 0.001$; $p < 0.0015$; $p < 0.01$), a higher CC-fraction ($p < 0.01$) and a higher arbitrary cardiac output simulated equivalent index ($p < 0.05$). Male gender could not be detected to be a predictor for higher tidal volume ($p = 0.70$; $p = 0.0212$).

Conclusion: In context of schoolchildren CPR, gender aspects are underestimated. Female students seem to be more motivated to attend CPR-training, reach more people in the role of a multiplier and need to be individually addressed in intensified practical training. Male students achieve a more sufficient chest compression depth and −fraction and could benefit from individual motivation.

Introduction

In western developed countries, between 275,000 and 420,000 people die from sudden cardiac arrest (SCA) each year [1,2]. Despite constant scientific refinement of guidelines for cardiopulmonary resuscitation (CPR), survival after SCA still amounts to only 6–9% [1,3,4]. Half of the survivors suffer from long-term neurocognitive impairment including memory and motoric deficits even years after the event [5,6]. While cerebral neurodegeneration is being initiated already 3–5 min after collapse due to hypoxemia, advanced life support (ALS) delivered by emergency medical services usually can be started 8–12 min after the emergency call [7]. Accordingly, immediate initiation of CPR by laypersons (bystander CPR) is highly recommended and regarded as most useful measure to reduce cerebral injury and increase survival after SCA [8,9].

In fact, bystander CPR-rates in most European countries are embarrassingly low [1,10]. Realizing this issue in the beginning of the 2000s, Denmark initiated a program to sustainably educate the population in basic life support (BLS) and subsequently increased lay-resuscitation rates from 21% to 45% within 9 years [11]. As key element of the program, schoolchildren received annual mandatory CPR-training. Therefore, a decisive contribution of schoolchildren CPR-

Abbreviations: ALS, advanced life support; BLS, basic-life-support; BMI, body mass index; CA, cardiac arrest; CC, chest compressions; CPR, cardiopulmonary resuscitation; ILCOR, International Liaison Committee on Resuscitation; KSL, KIDS SAVE LIVES; OHCA, out-of-hospital cardiac arrest; SCA, sudden cardiac arrest; VF, ventricular fibrillation

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training to a rise of bystander CPR-rates is presumed [11,12]. Taking Denmark as an example, multiple European-wide campaigns were initiated to establish schoolchildren CPR-programs [13]. Finally, in January 2015, the World Health Organization endorsed the "KIDS SAVE LIVES"-statement (KSL), which recommends mandatory CPR-training of 2 h per year in schoolchildren starting at the age of 12 years [14]. Along with the rising number of campaigns multiple authors investigated practical and theoretical CPR-performance as well as educational approaches related to schoolchildren CPR-training. Interestingly, some significant differences between males and females could be shown [15–17]. Consequently, to adequately educate schoolchildren in BLS and to further refine curricula for schoolchildren CPR-training, gender aspects need to be taken into consideration. Therefore, the objective of this article is to derive gender differences of practical and theoretical CPR-performance from the current literature.

Methods

Search strategy, data collection, and analysis

Reported data are in accordance with the PRISMA- (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Guidelines (Supplementary Table S1). Ethical approval was not needed to be obtained. A comprehensive search in PubMed-database and Cochrane-library was performed by two authors on November 25th 2017. Because of limited access, EMBASE-database was not searched. Controlled and uncontrolled prospective investigations evaluating the influence of gender on practical and theoretical performance of schoolchildren-CPR were included. Specific review questions were differences between female and male schoolchildren in (i) motivation and attitude towards CPR, (ii) detection of cardiac arrest (CA), (iii) performance of chest compressions related to depths and −rate, (iv) performance of mouth-to-mouth-ventilatioṅs related tidal volume, (v) use of an automatic external defibrillator, (vi) theoretical knowledge, (vii) multiplier effect and, (viii) in teaching methods.

Data extraction from the selected studies was performed using the key words "adolescent basic life support education" (305); "adolescent basic life support training" (176); "adolescent CPR education" (384); "adolescent CPR training" (463); "adolescent resuscitation education" (685); "adolescent resuscitation training" (845); "bystander CPR" (1363); "KIDS SAVE LIVES" (45); "schoolchildren AED" (10); "schoolchildren basic life support" (60); "schoolchildren cardiac arrest" (23); "schoolchildren CPR" (25); "schoolchildren resuscitation" (36) and "schoolchildren resuscitation theoretical knowledge" (2). The minimal age to be included was set to 9 years; due to the wide range of age in the study populations (e.g. 9–19 years [18]) it resulted an upper age of 20 years of schoolchildren. The reference list of included studies was also searched. Literature such as unpublished reports; theses; conference proceedings; newspapers; fact sheets; and websites were neither searched nor included. Duplicates were excluded. A first selection based on the titles and abstracts was conducted to identify potentially relevant articles (n = 2360). Abstracts were only excluded and any disagreements were resolved through discussion and consensus. In a second step; full-texts were checked for aptitude (n = 97). All studies meeting the review questions were included for full review (n = 24) and incorporated in the manuscript (Fig. 1).

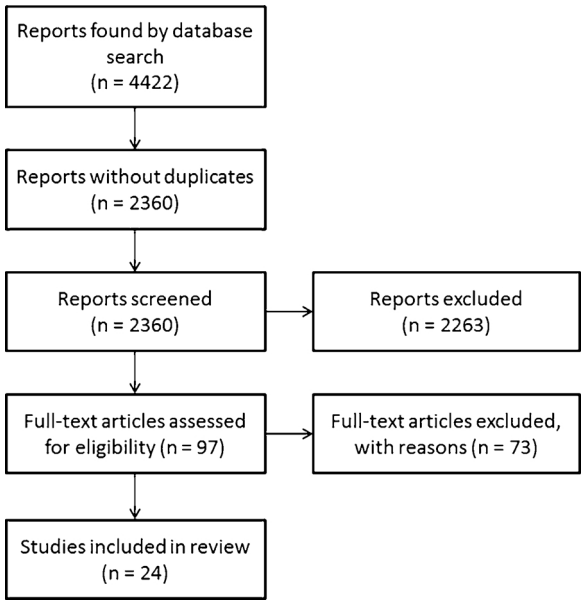

Fig. 1. Reported data are in accordance with the PRISMA- (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) Guidelines. A comprehensive search in PubMed-database was performed on November 25th 2017.

Results

For the present study, data of a total of n = 24 publications was used for analysis.

Motivation and attitude towards CPR and first aid

In a study with n = 1407 students (females: n = 732; males: n = 675) from 13 to 21 years (median 18 years), Huang et al. showed that being female is "independently associated with the willingness […]" to learn CPR (OR = 1.9) [19]. Kanstad et al. observed higher motivation in female students to attend CPR-training ($p < 0.001$) in a study including n = 376 students 16–19 years of age (females: n = 222; males: n = 154) [20]. In this study, 85% of female students were interested in CPR-training compared to 61% of male students ($p < 0.05$) [20]. Lester et al. reported higher intention to respond to CA in female students compared to male students ($p < 0.01$) in a study with n = 233 students (females: n = 115; males: n = 128) [21]. Parnell et al. reported a higher motivation of female students to learn first aid in a study with n = 494 students (females: n = 252; males: n = 217, gender not stated: n = 25) 16–17 years of age [22].

In another study by Lester et al. including n = 41 students (females: n = 24; males: n = 17) aged 11–12 years, 77% of male students thought that they would be capable to save a life after CPR-training compared to 38% of female students ($p < 0.05$) [23]. Furthermore, male students showed more confidence in CPR-proficiency compared to female students ($p < 0.05$) [20] (Table 1).

Detection of cardiac arrest

Toner et al. evaluated BLS training in n = 80 students (females: n = 53; males: n = 29; unknown n = 3) 10–12 years of age using a 22-point theoretical questionnaire, where detection of cardiac arrest (CA) was assessed in 8 questions. While overall scoring of both female and male students significantly improved between baseline and final score (females: 59.1%–75.9%; males: 55.4%–79,1%), a gender difference could not be detected [24]. Petris et al. analyzed drawings and questionnaires of n = 327 students (females: n = 172; males: n = 155) between 9 and 19 years after 45 min of BLS-training followed by a 5 min video sequence demonstrating CPR performance. Differences between females and males could not be shown in the questionnaire that contained 5 steps related to detection of CA (*p*-value was not given by the authors) [18].

Regarding the practical detection of CA, Frederick et al. reported significantly better airway assessment, head tilt and chin lift by female students ($p < 0.005$) in a study with n = 1292 students 10–11 years of age [25]. Furthermore, female students were found to better assess responsiveness ($p < 0.05$), to better look for signs of breathing ($p < 0.05$) and to better put the victim in the recovery position