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Original Article

Presence of physical symptoms in healthy adolescence found to be associated with female gender, obesity, tachycardia, diastolic hypertension and smoking

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Abstract: Background: The goal of this study was to evaluate any association between physical symptoms and abnormal clinical history in adolescence undergoing screening echocardiography performed by Anthony Bates Foundation. Method: The Anthony Bates Foundation has been performing screening echocardiography across the United States for the prevention of sudden death since 2001. We performed uni- and multivariate analysis to evaluate any association between physical symptoms with gender, smoking, obesity, heart rate, and hypertension. Results: We found a strong association between symptoms and the female gender (33% vs. 17.5% of males, $P < 0.001$). Furthermore, obesity (46.5% vs. 22.5%, $P < 0.001$), smoking (46.2% vs. 22.5%, $P = 0.04$), heart rate > 90 (34.8 vs. 22.8%, $P = 0.001$), and diastolic blood pressure > 90 (34.9% vs. 23.4%, $P = 0.03$) were all associated with symptoms. Increased systolic pressure was not associated with physical symptoms (24.3% vs. 21.9%, $P = 0.4$). Using multivariate analysis, female gender, diastolic blood pressure and obesity remained independently associated with physical symptoms. (Female gender: OR: 2.2, CI: 1.7-2.9, $P < 0.001$, obesity: OR: 2.5, CI 1.2-5.05, $P = 0.009$, and high diastolic blood pressure: OR: 2.08, CI 1.1-3.7, $P = 0.01$). Conclusion: Physical symptoms are associated with smoking, female gender, obesity, tachycardia, and high diastolic blood pressure but not systolic pressure in adolescence undergoing routine screening echocardiography.

Keywords: Obesity, smoking, cardiac symptom, palpitation, chest pain, fatigue, leg edema, screening echocardiography, teenagers

Introduction

It has been previously reported that there is significantly higher prevalence of physical symptoms in adolescents involved in athletic activities without any relation to cardiac abnormalities [1]. These physical symptoms include shortness of breath, palpitations, chest pain, dizziness, fatigue, and leg edema. Previous studies have shown that the female gender reports somatic symptoms more commonly [2, 3], including palpitations [4] and dizziness [6]. It has also been shown that a history of smoking correlates directly with shortness of breath [7], palpitations [8], chest pain [9], fatigue [9, 10], and dizziness [11]. Obesity in adolescents also correlates to fatigue [12], leg edema [12], palpitations [13], and chest pain [14]. The goal of this study was to further analyze any association between physical symptoms and gender, smoking, obesity, heart rate, and blood pressure in adolescents.

Methods

Data collections

Anthony Bates Foundation is a non-profit organization that was founded after Anthony Bates suffered a deadly cardiac arrest as a teenager. It aims to promote cardiac health education and cardiac screening in adolescents for the prevention of sudden cardiac death in young athletes. The Anthony Bates Foundation has conducted routine Electrocardiograph (EKG) and echocardiographic examinations of asymptomatic adolescent athletes at different high schools across the country since 2001. The

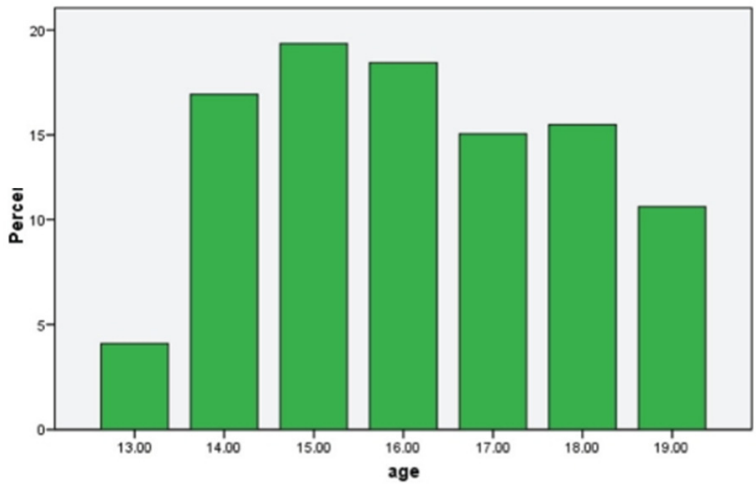

Figure 1. Age distribution of the study participants.

Table 1. Univariant Relationship With Reported Physical Symptoms

Characteristic	Reported Symptoms (%)
Gender	
Female	33*
Male	17.5
BMI	
> 30	46.5*
< 30	22.5
History of Smoking	
Smoker	46.2*
Non-Smoker	22.5
Heart Rate	
> 90	34.8*
< 90	22.8
Diastolic Blood Pressure	
> 90	34.9*
< 90	23.4
Systolic Blood Pressure	
> 140	24.3
< 140	21.9

Abbreviations: BMI, body mass index. *Correlation is significant at the 0.05 level.

plan of the study was that by detecting early significant cardiac abnormalities in healthy teenage athletes, many sudden cardiac deaths may be prevented in young athletes not aware of their cardiovascular disease. Participants signed a consent in order to undergo screening and teenagers < 18 years old had consents signed by their parent or legal gardian. The final report of their EKG and Echocardiographic findings were reviewed and confirmed by available volunteer cardiologists in different locations.

Demographics

Data from a total of 2,071 adolescents (age 13-19, **Figure 1**) with documented age, and 1,738 adolescents with documented BMI, with recorded physical symptoms, who had participated in the cardiac screening was utilized for this study retrospectively. Thirty-three percent of the participants were female. Most participants were involved in sports programs and were required to fill out a questionnaire where they reported the occurrence of any recent physical symptoms such as chest pain, palpitations, fatigue, dizziness, or shortness of breath [7-11, 20]. Included in this study were all participants over the age of 13 with available BMI who volunteered in the screening program. Participants less than years age and participants who did not have BMI measurements were excluded. The physical symptoms analyzed in this study included shortness of breath, palpitations, chest pain, dizziness, fatigue, and leg edema.

Statistical analysis

We performed Uni- and multivariate analysis adjusting for age and gender to identify any independent associations between the history of the above-mentioned physical symptoms documented on their questionnaire with gender, smoking, obesity, heart rate, and blood pressure. A *p*-value < 0.05 was regarded as statistically significant.

Results

Univariate results

Univariate analysis revealed the strongest associations between physical symptoms with the female gender (33% vs. 17.5% of male adolescents, P < 0.001). Additionally, smoking (46.2% vs. 22.5% of non-smokers reported symptoms, P = 0.04), obesity with a BMI > 30, (46.5% vs. 22.5%, P < 0.001), heart rate > 90

Table 2. Multivariant Relationship With Reported Physical Symptoms

Characteristic	OR	CI	Significance
Female Gender	2.2	1.7-2.9	p < 0.001
BMI > 30	2.5	1.2-5.05	p = 0.009
Diastolic Blood Pressure > 90	2.08	1.1-3.7	p = 0.01

(34.8% vs. 22.8%, P = 0.001), and diastolic blood pressure > 90 (34.9% vs. 23.4%, P = 0.03) were all associated with symptoms. Increased systolic pressure was not associated with the presence of physical symptoms (24.3% vs. 21.9%, P = 0.4) (**Table 1**).

Multivariate results

Using multivariate analysis, female gender, diastolic blood pressure, and obesity remained independently associated with physical symptoms. For female gender (OR: 2.2, CI: 1.7-2.9, P < 0.001), obesity (OR: 2.5, CI 1.2-5.05, P = 0.009), and for high diastolic blood pressure (OR: 2.08, CI 1.1-3.7, P = 0.01) (**Table 2**).

Discussion

This study was designed to analyze any association between reporting physical symptoms and demographics in adolescence. It has been previously established that these symptoms are more commonly reported by the female gender, individuals with smoking, and individuals with a BMI over 30 [1-14]. Our study confirms these correlations but additionally found an association between increased heart rate and high diastolic blood pressure with these symptoms in adolescents undergoing routine echocardiographic screening.

Multiple studies have found a correlation between the female gender and the occurrence of physical symptoms [1, 2, 15, 16]. Certain arrhythmias that are more prevalent in women include supraventricular tachycardia, sinus node dysfunctions, AV nodal re-entry tachycardia, and long QT syndrome that may partially be attributed to estrogen and progesterone levels. Arrhythmias may be accompanied by chest pain and shortness of breath [17]. Reported fatigue has also been associated with the female gender in both adults and adolescents with an emphasis on acute health complaints, hormones, and psychosocial complaints as contributing factors [18, 19]. However, many studies have discussed the social and psychological aspects of symptom reporting according to gender as a possible contributing factor [2, 15, 18]. Studies have identified women as being more readily willing to report symptoms than men due to socialization. Women typically have a lower threshold for seeking medical attention due to being more interpersonally oriented [2]. The more frequent contact with medical caregivers often occurring in women may also contribute to a more in-tune awareness of bodily discomfort and vigilance, therefore increasing symptom reporting [2].

It has been established that smoking directly correlates to respiratory disease, cardiovascular disease, osteoporosis, malignancy, and reduced fertility in both men and women [20]. These health concerns have been repeatedly associated with chest pain, palpitations, fatigue, dizziness, and dyspnea [7-11, 20]. Reported cardiorespiratory symptoms including, chest pain, palpations, and shortness of breath, may develop in adolescents with a history of smoking due to airway and lung damage caused by vasoconstriction and decreased oxygen saturation [21, 22].

Obesity has been also associated with fatigue, edema, chest pain, shortness of breath, and palpitations [12, 14]. Reported fatigue can be secondary to chronic inflammation resulting from obesity [23]. Decreased cardiac and respiratory function stemming from obesity commonly can lead to leg edema [24]. Cardiac arrhythmias and specifically atrial fibrillation have been reported more commonly in individuals with a BMI > 30 [25-27]. This correlation can be attributed to several direct and indirect mechanisms including increased blood pressure, cardiac fibrosis, increased production of inflammatory cytokines, atherosclerotic vascular lesions, and myocardial infarction [23].

Resting heart rate (RHR) has been shown to be related to overall health [28]. RHR elevation in adolescents is associated with markers of cardiovascular diseases including hypertension. Greater cardiorespiratory fitness is linked to higher efficiency in cardiac function and lower RHR [28]. Reported fatigue, palpitations, chest pain, dizziness, and shortness of breath in the

presence of elevated RHR may show a correlation to overall cardiorespiratory fitness in adolescents. This study establishes the correlation between high heart rate and reporting of physical symptoms. The causes of this association may be an overall poorer level of physical health that accompanies an elevated RHR thus leading to an increased presence of physical symptoms.

Chest pain, fatigue, palpitations, and dizziness have been linked to adults with long-term hypertension [29, 30]. Diagnosis of hypertension in adolescents is difficult due to the lack of symptoms associated with early stage of hypertension [31]. The underlying causes for diastolic hypertension in adolescents remain elusive but may contribute to the increase in reported symptoms. Our own experience has shown that females are more expressive than their male counterparts which can in part explain the higher prevalence of reporting physical symptoms in female participants.

Conclusion

We found a higher prevalence of reported physical symptoms in adolescents of the female gender, BMI > 30, smoking, heart rate > 90, and diastolic blood pressure > 90. The reason behind our findings is not clear as we performed only an observational study. It appears that obesity and hypertension can have a negative effect on well-being but the role of gender remains elusive. Prospective randomized trials are warranted to further evaluate our findings.

Limitations

This study is a retrospective study evaluating physical symptoms in a young population. Therefore, the result of this study cannot be extrapolated to the entire population particularly those of advanced age. Furthermore, we used a population undergoing screening health exam that introduce a bias to enroll only volunteers for screening limiting our results.

Disclosure of conflict of interest

None.

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