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Effect of physical activity status and dietary habits on pulmonary functions

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ABSTRACT

Background: There is a widely recognized fact that people who are more physically active and have healthy dietary habits tend to have a higher degree of fitness and physical activity that can promote respiratory health, which increases the efficiency of pulmonary function.

Objective: The aim of the present study was to explore the effect of physical activity, physical inactivity, and dietary habits on pulmonary function.

Materials and Methods: This cross-sectional study was performed during the period from August to December 2017, at the Faculty of Medicine, Omdurman Al-Ahlia University, Omdurman, Sudan. The study included 207 medical students (100 males–107 females) between the ages of 15 and 25 years. The smoker and the asthmatic were excluded. Pulmonary function test (PFT) was measured by using digital portable spirometer and peak flowmeter instruments. Arab Teens Lifestyle Study questionnaire was used for the determination of physical activity status and dietary habits.

Results: Data analysis showed that PFT parameters were statistically significantly higher in males than females (p-value 0.000). PFT parameters were significantly higher in active subjects (p-value 0.003), while the physical inactivity does not affect the PFT parameters. In addition, PFT parameters were significantly positively correlated with many physical activity types. PFT parameters were significantly negatively correlated with many foods stuff. PFT parameters were significantly positively correlated to height, weight, sum of metabolic equivalent, and age.

Conclusion: Our study concluded that physical activity and regular exercise improve the pulmonary function, and sedentary lifestyle has no direct effect on pulmonary function. Foodstuff with high fiber content was better than low fiber content for pulmonary function.

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Introduction

The normal pulmonary function can be monitored by pulmonary function tests (PFTs), which assesses the airflows and lung volumes [1]. The PFTs are a non-invasive test that aiding in the diagnosis of pulmonary impairment and assessing the severity of airways resistance [2].

Lifestyle and psychosocial interventions have been developed to prevent and manage chronic diseases. Field and laboratory studies help to specify causal pathways connecting lifestyle and psychosocial variables to disease processes. World Health Organization published report mentioned that over 60% of the deaths that occurred worldwide in 2008 resulted from non-communicable diseases (NCDs). The NCD deaths are expected to be increased globally by 15% by the end of 2020 [3]. During the past few decades, many studies assess the impact of nutrition and lifestyle changes on the health status of the people of the Eastern Mediterranean region [4,5].

There are a few studies that have addressed the relationship between dietary habits of young adult and physical activity as well as sedentary behaviors

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in large representative samples using reproducible and validated instruments [6–8]. Physical inactivity and sedentary behaviors were considered to be associated with adverse health outcomes [9]. Recent research findings have shown that sedentary behaviors time (television viewing) and physical inactivity appear to be independent entities and are separately associated with obesity and metabolic risk [10]. Excessive television viewing time among adolescents also appears to be related to unfavorable cardiovascular disease risks [11]. Moreover, physical activity was found to be associated more with healthy food choices, whereas sedentary behaviors appear to be linked more to unhealthy dietary choices [12].

In this study, we attempted to examine the association of pulmonary function with the physical activity levels, sedentary time, and dietary habits among medical students of Omdurman Al-Ahlia University (OAU).

Materials and Methods

Subjects

This cross-sectional study was conducted in the Faculty of Medicine, OAU, Omdurman, Sudan. Two hundred and seven students were recruited (100 males and 107 females) aged 15–25 years (as reported by the subjects). Each participant gave an informed oral consent before being invited to take part in the study. The Ethics committee of the International University of Africa, Sudan and the Board of the Department of Physiology, Faculty of Medicine, International University of Africa, approved the design and methods for this study. Asthmatic or/and smoker were excluded.

Measurement of anthropometric variables

Bodyweight was measured to the nearest 100 g using calibrated portable scales, with the subject in minimal clothing and without shoes. Height was measured to the nearest centimeter using a calibrated measuring rod when the subject was in a standing position without shoes.

Pulmonary function tests (PFT)

Forced vital capacity (FVC)

Measured by digital portable spirometer (Clement Clarke One Flow Spirometer—made in UK) and disposal mouthpiece, the standard technique was demonstrated to participants. The maneuver takes deep inspiration then put their mouth firmly attached to mouthpiece of the spirometer and then forcibly expired till it empties their lung.

Forced expiratory volume in 1 second

The FEV1 was calculated automatically by spirometer as part of results including FVC, FEV1, and FEV1/FVC ratio and then data obtained from programmed digital spirometer using the same maneuver mentioned above.

Peak expiratory flow rate (PEFR)

PEFR was measured by the peak flow-meter instrument (Mini Wright Peak Flow-standard EU scale) and disposal mouthpiece, the standard technique demonstrated to participants. The maneuver takes deep inspiration then put their mouth firmly attached to mouthpiece of peak flow-meter and then forcibly expired in one exhaled cycle.

Physical activity, physical inactivity, and dietary habits were assessed by using the Arab Teens Lifestyle Study (ATLS).

ATLS questionnaire

This questionnaire was internationally validated and reliable, which designed to collect complete information on frequency, duration, and intensity of a variety of light-, moderate-, and vigorous intensity physical activities during a typical (usually) week.

The physical activity questionnaire covers such domains as transport, the household, fitness, and sports activities. Moderate-intensity physical activity includes activities such as normal pace walking, brisk walking, recreational swimming, household activities, and moderate-intensity recreational sports such as volleyball, badminton, and table tennis. Moderate-intensity physical activities were assigned metabolic equivalent (MET) values based on the compendium of physical activity and the compendium of physical activity for youth. Household activities were given a mean MET value of 3. Moderate-intensity recreational sports were assigned an average MET value equivalent to four METs. Vigorous-intensity physical activity and sports included activities such as stair-climbing, jogging, running, cycling, self-defense, weight-training, and vigorous-intensity sports such as soccer, basketball, handball, and single tennis. Vigorous-intensity sports were assigned an average MET value equivalent to eight METs. Slow walking, normal-pace walking, and brisk walking were assigned MET values of 2.8, 3.5, and 4.5 METs, respectively, based on modified METs values from the compendium of physical activity for youth.

Furthermore, the physical activity questionnaire contains some additional questions on reasons for being active or inactive such as “Where and when do you usually exercise? and “With whom do you usually exercise?”

Measurement of physical activity levels

Two measures of physical activity levels are used in the ATLS. The first measure of physical activity levels is the total number of minutes spent in physical activity per week as well as the number of minutes spent in moderate- and vigorous-intensity physical activity per week. The minimal activity level based on time spent on physical activity per week was calculated according to the minimal recommended physical activity for children and youth, which is 1 hour of at least moderate-intensity activity per day. This is an equivalent of 420 minutes per week (60 minutes multiplied by 7 days per week). The second measure of physical activity that is used in the ATLS considers both time and intensity of physical activity. This includes the total METs minutes per week as well as the METs minutes per week resulting from each moderate- and vigorous-intensity physical activity. This is an equivalent of the sum of time spent in specific activity per week multiplied by the MET value of that activity.

Participants were divided into physically active or inactive based on total physical activity cut-off scores of 1,680 METs minutes per week (60 minutes per day × 7 days per week × 4 METs), corresponding to 1 hour of daily moderate-intensity physical activity.

Sedentary behavior time

The section on sedentary activity and sleeping hours follows the physical activity questions and aims to determine important information related to the daily time spent on TV viewing, video games, and computer and Internet use, as well as the number of sleeping hours per day (night and day). For a maximal cut-off value for total screen time, we used 2 hours per day, recommended by the American Academy of Pediatric guidelines.

Dietary habits questionnaire

In addition to the physical activity questionnaire, in a separate section, the ATLS questionnaire included 10 specific questions designed to collect the frequency of certain dietary habits. They included questions related to how many times per week does the participant consume breakfast, sugar-sweetened drinks including soft beverages, vegetables (cooked and uncooked), fruits, milk and dairy products, donuts/cake, sweets and chocolates, energy drinks, and fast foods. The fast foods in this regard include some examples from both Western fast foods as well as some Arabic fast-food choices such as shawarma (grilled meat or chicken in pita bread with some salad). These questions cover some healthy and unhealthy dietary habits. The student has a choice of answers ranging from zero intakes (nothing) to a maximum intake of 7 days per week (every day).

Data analysis

Data were analyzed by using PASW for Windows® version 24.0 software (formerly SPSS Statistics Inc. Chicago, IL). Results were presented as mean ± standard deviations for all variables. Student *T*-test was used to compare between two groups. Pearson correlation was used to correlate between PFT and other variables. $p < 0.05$ was considered a significant difference.

Results

Of the 207 participants, there were slightly more females than males. There was a significant difference between males and females in mean age. Weight and height were significantly higher in males (Table 1).

Regarding the PFT, FVC, FEV1, and PEFR were statistically significantly higher in males. There is no significant difference between males and females in the FEV1/FVC ratio (Table 2).

Concerning the effect of physical activity and inactivity on the PFT; FVC, FEV1, and PEFR are significantly

Table 1. Anthropometric variables of the study group.

Variables	Males (n = 100)	Females (n = 107)	
	Mean ± SD	Mean ± SD	p-value
Age (years)	19.50 ± 1.580	19.07 ± 1.1	0.02
Weight/kg	67.04 ± 13.875	60.57 ± 13.239	0.001
Height/cm	1.7159 ± 0.6425	1.5875 ± 0.05740	0.000

Table 2. Comparison of PFT between males and males.

PFT	Males (n = 100)	Females (n = 107)	
	Mean ± SD	Mean ± SD	p-value
FVC	4.3930 ± 0.65748	3.1748 ± 0.46451	0.000
FEV1	3.5075 ± 0.51476	2.5023 ± 0.33424	0.000
FEV1/FVC%	79.9987 ± 4.54973	79.1589 ± 5.61897	0.241
PEFR	518.83 ± 68.134	346.50 ± 55.848	0.000

higher in active subjects, but there is no significant difference when comparing the PFT between males and females separately (Table 3). While the physical inactivity does not affect the PFT parameters (Table 4).

PEFR was significantly negatively correlated to sleep time per day. There is no significant correlation between PFT parameters and other types of sedentary behavior time (Table 5).

The correlation of PFT with the frequency and duration of different types of physical activity revealed that FVC, FEV1, and PEFR are significantly positively correlated to frequency and duration of moderate-intensity activity, frequency and duration of high-intensity activity, frequency and duration of weight training or body building and significantly negatively corralled to frequency and duration of household activity. FVC significantly positively correlated to the frequency of use cycle, frequency and duration of swimming. FEV1 is significantly positively correlated to the frequency

Table 3. PFT relative to gender and physical activity.

PFT		Male			Female			Males and females		
		Active	Inactive	*p*-value	Active	Inactive	*p*-value	Active	Inactive	*p*-value*
	N	39	61		20	87		59	148	
FVC	Means	4.4782	4.3385	0.302	3.1675	3.1764	0.939	4.033	3.6554	0.003
	SD	0.61299	0.68376		0.4190	0.47659		0.833	0.8081	
	N	39	61		20	87		59	148	
FEV1	Means	3.5423	3.4852	0.591	2.4975	2.5034	0.943	3.188	2.9081	0.006
	SD	0.49037	0.5327		0.24359	0.35296		0.653	0.6509	
	N	39	61		20	87		59	148	
PEFR	Means	520.46	517.79	0.849	347.25	346.33	0.948	461.7	417.00	0.006
	SD	61.459	72.558		50.925	57.195		100.8	105.988	

Table 4. PFT relative to gender and sedentary time.

PFT		Male			Female			Total		
		Low	High	*p*-value	Low	High	*p*-value	Low	High	*p*-value*
	N	8	92		7	100		15	192	
FVC	Means	4.1000	4.4185	0.190	3.1429	3.1770	0.852	3.6533	3.7719	0.596
	SD	0.73921	0.64810		0.58554	0.45845		0.8151	0.8341	
	N	8	92		7	100		15	192	
FEV1	Means	3.2563	3.5293	0.151	2.5071	2.5020	0.969	2.9067	2.9943	0.623
	SD	0.50740	0.51229		0.49196	0.32395		0.6181	0.66649	
	N	8	92		7	100		15	192	
PEFR	Means	524.13	518.37	0.820	366.43	345.11	0.331	450.53	428.13	0.433
	SD	45.643	69.910		52.497	56.058		94.097	107.184	

Table 5. The correlation between PFT and sedentary time.

		TV, videos per day	Computer, Internet per day	TV, videos per weekend	Computer, internet Per weekend	Sleep in a day	Sleep during weekend
FVC	Correlation	−0.039	0.026	−0.004	−0.055	−0.064	0.063
	Sig. (2-tailed)	0.573	0.707	0.959	0.430	0.360	0.369
FEV1	Correlation	−0.053	0.026	0.009	−0.047	−0.080	0.046
	Sig. (2-tailed)	0.445	0.705	0.899	0.504	0.251	0.508
FEV1/FVC%	Correlation	−0.044	0.021	0.050	0.040	−0.069	−0.042
	Sig. (2-tailed)	0.527	0.762	0.472	0.562	0.324	0.547
PEFR	Correlation	−0.093	−0.066	−0.038	−0.133	−0.143	0.005
	Sig. (2-tailed)	0.184	0.344	0.592	0.055	**0.040**	0.945

and duration of swimming. PEFR is significantly positively correlated to the duration of jog or run, frequency and duration of use cycle (Table 6).

The correlation of PFT parameters with the dietary habits revealed that FVC, FEV1, and PEFR are significantly negatively correlated to eat French fries and/or potato chips, cakes, biscuits, donuts, or similar foods and eat sweets and/or chocolates. PEFR is significantly negatively correlated to eat fast foods (burger, sausage, pizza, etc.) (Table 7).

Discussion

This study investigates the relationship between PFTs and participants' lifestyle including physical activity, sedentary times, and dietary habits. Smokers and people suffering from the chronic obstructive pulmonary disease have been excluded because these factors have a direct impact on PFTs, which has been confirmed by many previous studies.

The present study revealed that mean FVC, FEV1, and PEFR are significantly higher in males than females. FEV1/FVC ratio is statistically similar in males and females. These findings explained by the significant increase in the two major factors that have a greater influence on PFT which are height and age; in the present study, males were taller and older than females. These findings agreed with a study that evaluates the pulmonary functions of medical students in Nepal, which found a significant increase in PFT

Table 6. The correlation between PFT and types of physical activity.

Types of physical activity		FEV1	FVC	PEFR
Regularly jog or run (minutes each time)	Pearson Correlation	0.121	0.135	0.199
	Sig. (2-tailed)	0.083	0.053	**0.004**
Regularly use cycle (outdoor or stationary cycle) (per week)	Pearson Correlation	0.142	0.093	0.177
	Sig. (2-tailed)	**0.041**	0.183	**0.011**
Regularly use cycle (outdoor or stationary cycle) (minutes each time)	Pearson Correlation	0.088	0.050	0.170
	Sig. (2-tailed)	0.209	0.478	**0.014**
Regularly swim (per week)	Pearson Correlation	0.153	0.161	0.099
	Sig. (2-tailed)	**0.027**	**0.021**	0.154
Regularly swim (minutes each time)	Pearson Correlation	0.187	0.184	0.118
	Sig. (2-tailed)	**0.007**	**0.008**	0.090
Regularly engage in moderate intensity sports (e.g., Volleyball) (per week)	Pearson Correlation	0.195	0.200	0.180
	Sig. (2-tailed)	**0.005**	**0.004**	**0.010**
Regularly engage in moderate intensity sports (minutes each time)	Pearson Correlation	0.156	0.173	0.154
	Sig. (2-tailed)	**0.025**	**0.013**	**0.027**
Regularly play high intensity sports (e.g., Basketball) (per week)	Pearson Correlation	0.293	0.296	0.236
	Sig. (2-tailed)	**0.000**	**0.000**	**0.001**
Regularly play high intensity sports (e.g., Basketball) (minutes each time)	Pearson Correlation	0.325	0.341	0.334
	Sig. (2-tailed)	**0.000**	**0.000**	**0.000**
Participate in self-defense sports (e.g., Judo) (per week)	Pearson Correlation	0.106	0.108	0.181
	Sig. (2-tailed)	0.131	0.123	**0.009**
Participate in self-defense sports (e.g., Judo) (minutes each time)	Pearson Correlation	0.137	0.130	0.138
	Sig. (2-tailed)	**0.048**	0.061	**0.047**
Regularly do weight training or body building (per week)	Pearson Correlation	0.439	0.432	0.372
	Sig. (2-tailed)	**0.000**	**0.000**	**0.000**
Regularly do weight training or body building (minutes each time)	Pearson Correlation	0.441	0.419	0.350
	Sig. (2-tailed)	**0.000**	**0.000**	**0.000**
Engage in household work (e.g., Gardening, washes) (per week)	Pearson Correlation	−0.204	−0.200	−0.245
	Sig. (2-tailed)	**0.003**	**0.004**	**0.000**
Engage in household work (e.g., Gardening) (minutes each time)	Pearson Correlation	−0.196	−0.203	−0.254
	Sig. (2-tailed)	**0.005**	**0.003**	**0.000**

Table7. Correlation between PFT and dietary habits.

		Breakfast	Sugary drinks	Vegetables	Fresh fruits	Dairy product	Fast foods	Potato chips	cakes biscuits	Sweets chocolates	energy drinks
FVC	Pearson Correlation	0.022	0.016	−0.002	0.020	0.063	−0.106	−0.149	−0.183	−0.228	−0.006
	Sig. (2-tailed)	0.750	0.817	0.973	0.772	0.370	0.127	**0.032**	**0.008**	**0.001**	0.931
FEV1	Pearson Correlation	0.061	0.045	−0.027	−0.015	0.090	−0.128	−0.151	−0.178	−0.218	−0.002
	Sig. (2-tailed)	0.385	0.518	0.701	0.831	0.197	0.066	**0.030**	**0.010**	**0.002**	0.979
PEFR	Pearson Correlation	0.088	−0.004	0.019	0.067	0.121	−0.172	−0.181	−0.185	−0.193	0.049
	Sig. (2-tailed)	0.207	0.950	0.783	0.335	0.082	**0.013**	**0.009**	**0.008**	**0.005**	0.488

parameters in males as compared to females [13]. In the present study, FVC, FEV1, and PEFR are statistically significantly higher in active subjects; this is consistent with study that documented physical activity improves the PFT [14], which was explained by the fact that regular exercises improve PFT parameters by strengthening the respiratory muscles that allow better chest expansion and, therefore, improving the lung vital capacities. Also, our study in accordance with study found after controlling for covariates, being active and not being a recent smoker were associated with better cardiopulmonary fitness and PFT in both men and women [15], in addition it recommended that persons who remained or became active had better PFT than persons who remained or became sedentary and physical activities improve FEV1 and FVC than the sedentary individual [15]. Recent study showed that the pulmonary functions of individuals having regular exercises become better than that of sedentary individuals [16]. Our present study revealed that many types of sports have a positive impact on lung function. Sports type with a high positive impact is cycle, swim, moderate-intensity sports, high-intensity sports, and weight lifting or body building. Our findings in agreement with a study that reported active lifestyles had a positive effect on the lungs by increasing pulmonary capacities and enhancing lung functioning [17].

Regarding the effect of sleeping hours on lung function, the present study showed that good sleep for appropriate hours during the day has no effect on lung function because most of the study population sleeping hours is within normal range. Our findings go with the study that reported severe sleep deprivation may have an impact on physical health and cardiopulmonary, which secondarily have a negative impact on PFT [19].

Regarding the dietary habits, the present study found that there is a negative correlation between PFT parameters with many foods stuff, most of these foods stuff are generally, either of low fiber or of high sugar. Most of the participants in our study consuming fast foods, potato chips, cakes and biscuits and sweets and chocolates, which are regarded as of low fiber and sugary diet. These findings in consistence with the study that reported food of low fiber content intake was associated with a reduction in all parameters of lung function test and diet rich in fiber may play a role in the improvement of pulmonary function [19].

Conclusion

Our findings revealed that physical activity and regular exercise improve the pulmonary function. In addition, sedentary lifestyle has no direct effect on pulmonary health; but indirectly has a negative impact through decrease of the physical activities and regular exercise periods. Sedentary effects might need long time to appear. Concerning dietary habit, high caloric food stuff such as French fries and potato chips and high sugary foods were inversely associated with the pulmonary health.

Recommendations

Further study needs to figure out which type of sports improves PFT better than others. Furthermore, the relationship between dietary fibers and PFT needs to be investigated.

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