Original Research

Smoking and Physical Activity Interrelations in Health Science Students. Is Smoking Associated with Physical Inactivity in Young Adults?

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Key words: **Physical activity, physical inactivity, smoking.**

Background: Smoking and physical inactivity constitute a major public health concern for Greece. The purpose of this study was to examine smoking behaviour and physical activity (PA) in Greek health science students.

Methods: A standardised questionnaire and the Greek version of IPAQ-short were given to 2000 health science students, randomly selected from five higher education institutions, in order to record smoking behaviour and PA status. All healthy young adults aged 19-30 years old were eligible. The final cohort size of the study was 1651 students (690 men).

Results: In the overall population, smoking prevalence was 37.6%, with 23.1% being heavy smokers (≥21 cig/day). Smoking prevalence did not differ significantly between sexes, but heavy smoking was more prevalent in males. Age at smoking initiation was negatively associated with the daily number of cigarettes smoked (smoking volume), but only in females. The prevalence of health-enhancing PA (high PA_{class}) was only 14.2%, while 45.4% of the study population was classified as insufficiently active (low PA_{class}). Males were more physically active than females. Logistic regression analysis showed a strong inverse association between smoking and PA that was more pronounced in males. Smoking was associated with significantly decreased odds of being either moderately or highly physically active. Smoking volume was also negatively related with PA, but this relation was more pronounced in females.

Conclusion: Smoking prevalence and rates of physical inactivity are considerably high in Greek health science students. Smoking was strongly and inversely associated with PA in this sample of Greek young adults.

Manuscript received: August 22, 2011;
Accepted: November 22, 2011.

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Smoking and physical inactivity are strongly related to a deterioration in overall health status and are among the most important modifiable risk factors for chronic disease and premature death.[1,2]

Smoking ranks among the top causes of cardiovascular disease[3] and certain types of cancer, and is a major cause of chronic obstructive pulmonary disease.[2] It is the leading preventable cause of death around the world.[2,4] About 5 million deaths per year globally were attributed to smoking at the beginning of the 21st century.[2] In the World Health Organisation (WHO) European Region, smoking is the second most important risk factor in the burden of disability-adjusted life years (DALYs) and is the primary risk factor for premature mortality, associated with about 1.6 million deaths each year.[5] Smoking prevalence still remains high in the European Union (EU), where approximately 30% of EU citizens are smokers.[6] The as-

sociated public health problems include 15% of all-cause deaths being attributed to smoking, representing some 655,000 smoking-related deaths each year in the EU.[7]

Although a plethora of epidemiological studies have underscored the importance and effectiveness of physical activity (PA) and exercise,[8-10] the prevalence of physical inactivity is increasing worldwide, to the extent that it has become a substantial public health concern and a considerable economic burden.[1,11] Low levels of PA are inversely related with cardiovascular morbidity,[12] increase the risk of certain types of cancer[8] and metabolic diseases,[12] and are strong prognostic indexes of all-cause mortality.[8,13] Globally, physical inactivity is estimated to cause 1.9 million deaths per year, while in the European zone the percentage of all-cause deaths attributed to physical inactivity ranges from 5% to 10%.[1]

Greece suffers from an enormous smoking-related public health problem, having the highest proportion of smokers (42%) in the EU.[6] In addition, rates of physical inactivity and abstention from exercise in Greece are at a record high among EU countries,[14] and to make matters worse they are rapidly increasing.[15] Although the health effects of smoking and physical inactivity are extensively discussed in Greek society, published findings indicate that about four out of ten young Greeks are smokers,[16,17] while the prevalence of PA among the Greek youth is far below the average among many European countries.[18,19] In addition, little is known regarding possible smoking-PA interrelations in young population samples.

Therefore, the study of smoking behaviour and PA status in young adults is of critical importance for public health, not only for Greece, but also for many other countries with a high smoking prevalence and a largely sedentary population. In the present study, we focused on young people who were studying medicine or health sciences—a population of special interest, as it can be expected to include individuals who will be helping to guide health care policies in the future. The main objectives of the present study were to study the smoking behaviour and PA status in Greek health science students, and to search for possible smoking-PA associations in this sample of young adults.

Methods

Study population

Five higher education institutes participated in this multi-centre cross-sectional study. The study period was from February 2008 to June 2009, before a platform of strict anti-smoking measures came into force in Greece (July 1, 2009). The subjects were randomly selected from a target population of health science students from the Medical School of Athens University, the Medical School of Ioannina University, and the Physical Therapy departments of the Technological Educational Institute (TEI) of Athens, TEI of Lamia and TEI of Patras. A standardised, self-addressed questionnaire and the Greek version of the short International Physical Activity Questionnaire were given to 2000 students in order to record anthropometric data, health-related information, smoking behaviour, dietary habits and PA status. The study protocol and all questionnaire administration procedures were extensively discussed and standardised at the beginning of the study. All healthy young adults aged 19-30 years old were eligible to participate. Health status was assessed by the physician team of the research group, based on health-related items of the questionnaire. All subjects who had health-related problems that might have interfered with their ability to participate in PAs (recent musculoskeletal injuries, pregnancy, metabolic disease, current illness, etc.) were excluded. Written informed consent was obtained from all participants. The participation rate was high (82.5%), even though no incentives were offered. Of the 349 students excluded, 108 reported health-related problems, 212 returned questionnaires with missing data and 29 refused to participate. The final cohort size of the study was 1651 students (690 men; Table 1). The study protocol followed the principles of the Helsinki Declaration and was approved by the research committee of Athens TEI.

Smoking behaviour

Subjects were classified as current smokers (smoking during the last 30 days), ex-smokers (given up smoking more than one month before) and non-smokers (never smoked). Current smokers were classified into three ordered smoking volume sub-categories, depending on the daily number of cigarettes (cig/day) smoked: 1) 0-10 cig/day, light smokers; 2) 11-20 cig/day, moderate smokers; 3) ≥21 cig/day, heavy smokers. The very small number of occasional smokers was grouped with current smokers, sub-category 1 (0-10 cig/day). Among other data, age at smoking initiation and smoking years were also recorded.

Table 1. Personal characteristics, smoking behaviour and physical activity status of the study population.

	Total (n=1651)	Males (n=690)	Females (n=961)	p*
Age (years)	22.1 ± 2.6	22.5 ± 2.8	21.9 ± 2.5	NS
BMI (kg/m^2)	22.7 ± 3.6	24.5 ± 3.7	21.5 ± 3.0	<0.001
Smoking behaviour:				
Smoking (%)	37.6	39.6	36.1	NS
Smoking initiation (years)	17.6 ± 2.0	17.5 ± 2.1	17.7 ± 2.0	NS
Smoking years	4.4 ± 2.9	5.0 ± 3.2	4.0 ± 2.6	<0.001
Smoking volume (cig/day)				
0-10 /11-20/ ≥ 21 (%)	36.1 /40.8/ 23.1	30.4 /40.3/ 29.3	40.6 /41.2/ 18.2	<0.001†
PA status:				
Total PA_{score}	1198/730 (347-1596)	1405/924 (396-1920)	1050/612 (330-1347)	<0.001
Vigorous PA_{score}	566/0 (0-720)	801/320 (0-1200)	397/0 (0-480)	<0.001
Moderate PA_{score}	227/40 (0-320)	241/80 (0-360)	217/0 (0-320)	NS
Walking PA_{score}	405/297 (132-495)	362/248 (99-462)	435/330 (165-495)	<0.001
Regular walking (%)	26.8	23.2	29.3	0.007
Low PA, sedentary (%)	45.4	39.7	49.4	<0.001
Moderate PA (%)	40.5	41.6	39.6	NS
High PA, HEPA (%)	14.2	18.7	10.9	<0.001

BMI – body mass index; HEPA – health-enhancing physical activity; NS – non-significant; PA – physical activity.
Age, BMI, age at smoking initiation and smoking years are expressed as mean ± SD. PA_{scores} are expressed as mean/median and (25th-75th percentiles). Smoking prevalence is expressed as percentage of current smokers.
*Comparisons between males and females. †Comparison of the prevalence of heavy smoking between the sexes.

Physical activity assessment

The PA status of the subjects was evaluated using the Greek International Physical Activity Questionnaire (IPAQ-Gr), which has shown good to high reliability[20] and adequate validity[17] in young adults. Briefly, the purpose of this instrument is to sum up vigorous, moderate and walking PAs over the previous seven-day period and generate a total physical activity score (PA_{score}), expressed in metabolic equivalent (MET)-minutes per week (MET·min·wk^{-1}). Based on the IPAQ scoring procedure,[20] PA status was classified into three categories ($PA_{classes}$): 1) low PA_{class}, insufficiently active subjects (total PA_{score}<600 MET·min·wk^{-1}); 2) moderate PA_{class}; and 3) high PA_{class}, HEPA active subjects[21,22] (HEPA: health-enhancing physical activity, i.e. total PA_{score}≥3000 MET·min·wk^{-1} or vigorous PA_{score}≥1500 MET·min·wk^{-1}). In addition, the prevalence of regular walking was recorded (cut-off point: walking PA_{score} ≥ 495 MET·min·wk^{-1}, equivalent to 5 days × 30 min per week).[21]

Data analysis

Statistical analysis of the data was performed using the SPSS v.17 software package (SPSS Inc., Chicago IL, USA). Age and body-mass index (BMI) values were normally distributed (Kolmogorov-Smirnov test) and are presented as mean ± standard deviation. IPAQ-Gr PA_{scores} were skewed and are presented as mean/median and 25th-75th percentile values. Analysis of variance for anthropometric indices and the Mann-Whitney U test for continuous (i.e. PA_{scores}) or chi-square for categorical (i.e. PA_{class}) non-parametric data were used to examine differences between the sexes and between non-smokers and current smokers. Full factorial multinomial logistic regression analysis was used to examine the cross-sectional smoking-PA association further. The models included smoking as the factor (independent) variable and PA_{class} as the outcome (dependent) variable. Based on similar studies,[23,24] sex, age and BMI may affect the smoking-PA relationship and so they were included in the multinomial logistic regression model as covariates. Odds ratios (ORs) with 95% confidence intervals (CI), adjusted for age, BMI and sex, were computed. In addition, interrelations between sex, BMI, smoking and PA were examined. Finally, the relationship between smoking volume and PA in smokers was tested using ordered smoking volume as the independent variable, PA_{class} as the dependent outcome and the covariates described above. The level of significance in all analyses was set as a p-value less than 0.05.

Results

Smoking behaviour

In the total population, smoking prevalence was 37.6% (Table 1). Light smokers accounted for 36.1% of the smoking population, 40.8% were moderate smokers, and 23.1% were heavy smokers. The average age at smoking initiation was 17.6 years and did not differ between sexes. About 4.4% of current smokers started smoking during childhood (<14 years), 69.6% during adolescence (14-18 years), while 26.0% started smoking as adults (>18 years).

Regarding sex-related differences, smoking prevalence was higher, though not statistically so, in males compared to females (adjusted OR for males: 1.18, p=0.172). However, heavy smoking was more prevalent in males (Table 1). Men were 1.90 times more likely to be heavy smokers compared to women (p=0.009). Age at smoking initiation was not associated with smoking volume in males, but these variables were significantly and negatively correlated in females (light smokers initiated smoking at age 18.4, moderate smokers at 17.6 and heavy smokers at 16.4 years, p<0.001).

Finally, no significant differences in BMI were found between non-smokers and current smokers in either male (24.3 vs. 24.7) or female (21.4 vs. 21.6) subjects.

Physical activity status

Based on the IPAQ classification criteria, 45.4% of the total study population was insufficiently active (low PA: total PA_{score}<600 MET·min·wk^{-1}, Table 1). About 15% of the participants had a total PA_{score} less than 200 MET·min·wk^{-1} and 11% less than 150 MET·min·wk^{-1}. Furthermore, 56.4% of the subjects reported zero vigorous PA, 49.7% did not do any moderate PA, 10.4% reported zero walking PA and only 14.2% of the participants were classified as HEPA active subjects. The prevalence of regular walking in the total population was 26.8%.

Regarding sex-related differences, males were found to be more physically active than females. Total and vigorous PA_{scores} were significantly higher for male subjects (Table 1). Men were 2.77 times more likely to have high PA status compared with women (p<0.001). However, the prevalence of regular walking and walking PA_{score} were significantly higher for females.

Finally, BMI was marginally higher in subjects with a low PA_{class} compared with HEPA subjects, in both men (24.7 vs. 24.1, p=0.047) and women (21.6 vs. 21.0, p=0.035).

Smoking – PA association

Data for subjects' smoking profile in relation to PA level are presented in Table 2. Both male and female non-smokers had a significantly higher total PA_{score} than current smokers. In addition, there was an inverse relation between smoking prevalence and PA level (smoking prevalence in low PA=45.4%, in moderate PA=34.3%, and in high PA=21.8% of the to-

Table 2. Total physical activity score and prevalence of regular walking per smoking group. Comparison of smoking behaviour at each physical activity level.

Physical activity	Smoking status			p*
	Non-smokers	Ex-smokers	Current smokers	
Males (n=690)	(n=355)	(n=62)	(n=273)	
Total PA_{score}	1188 (495-2292)	1194 (491-2045)	563 (264-1469)	<0.001
Regular walking (%)	26.8	22.6	18.7	0.022
Low PA (%) (n=274)	39.8	8.0	52.2	0.005
Moderate PA (%) (n=287)	53.7	10.8	35.5	<0.001
High PA (%) (n=129)	71.3	7.0	21.7	<0.001
Females (n=961)	(n=549)	(n=65)	(n=347)	
Total PA_{score}	690 (359-1415)	678 (318-1439)	530 (297-1177)	0.005
Regular walking (%)	31.1	32.3	25.9	NS
Low PA (%) (n=475)	52.4	6.1	41.5	0.001
Moderate PA (%) (n=381)	59.3	7.3	33.3	<0.001
High PA (%) (n=105)	70.5	7.6	21.9	<0.001

Abbreviations as in Table 1. PA_{score} is expressed as median (25th-75th percentiles).
*Comparisons between non-smokers and current smokers weighted for group sizes.

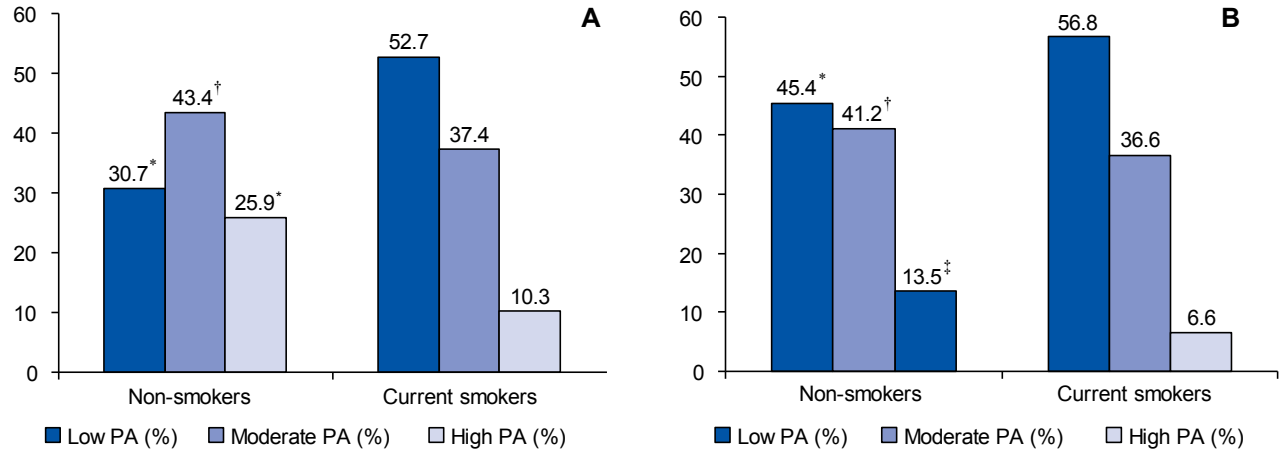

Figure 1. Physical activity (PA) classification in relation to smoking status in males (A) and females (B). *p<0.001 for the difference between non-smokers and current smokers; †non-significant differences between non-smokers and current smokers; ‡p=0.018 for the difference between non-smokers and current smokers.

tal population, p<0.001). When PA classification per smoking group was examined (Figure 1), the prevalence of a high PA status was greater in non-smokers than in current smokers (25.9% vs. 10.3%, p<0.001 for males and 13.5% vs. 6.6%, p=0.18 for females). In contrast, the prevalence of being sedentary was lower in non-smokers compared to current smokers in both sexes (30.7% vs. 52.7%, p<0.001 for males and 45.4% vs. 56.8%, p<0.001 for females).

Logistic regression analysis showed a strong negative relationship between smoking and PA (Table 3). In the total population, smoking was associated with significantly decreased odds of having a high (OR=0.36, p<0.001) or moderate PA status (OR=0.60, p<0.001), as opposed to a low PA score (Table 3). Similar relationships were found when data were analysed by sex, with the negative smoking-PA relationship being more pronounced in males (Table 4). Smoking volume was in general negatively related with PA. More specifically, heavy smoking was associated with significantly decreased odds of being HEPA active in the total population (OR=0.37, p<0.019, data not shown) and in females (OR=0.19, p<0.041, Table 5). However, this relationship was not significant in males. Finally, age and BMI did not affect either smoking-PA or smoking volume-PA relationships in any of the subgroups examined.

Table 3. Multinomial logistic regression (MLR) model for the association between smoking and physical activity status (total population).

PA class	Variable	OR (95% CI)	p
Moderate PA	Age	1.04 (1.00-1.09)	NS
	BMI	0.99 (0.95-1.02)	NS
	Current smokers	0.60 (0.48-0.75)	<0.001
	Non-smokers	1.00	
High PA	Age	0.95 (0.89-1.02)	NS
	BMI	0.95 (0.90-1.01)	NS
	Current smokers	0.36 (0.25-0.52)	<0.001
	Non-smokers	1.00	

BMI – body mass index; CI – confidence interval; NS – non-significant; ORs – odds ratios adjusted for age – BMI and sex; PA – physical activity. In MLR analysis, low PA class for physical activity and non-smokers for smoking were set as the reference categories. Odds ratios <1.0 indicate that current smokers are less likely to have moderate or high PA status relatively to low.

Table 4. Adjusted odds ratios for the association between smoking and physical activity status in males and females.

		OR (95% CI)	p
Males:			
Moderate PA	Current smokers	0.53 (0.37-0.77)	0.001
	Non-smokers	1.00	
High PA	Current smokers	0.27 (0.16-0.44)	<0.001
	Non-smokers	1.00	
Females:			
Moderate PA	Current smokers	0.64 (0.48-0.87)	0.004
	Non-smokers	1.00	
High PA	Current smokers	0.40 (0.24-0.67)	<0.001
	Non-smokers	1.00	

Abbreviations as in Table 3. In MLR analysis, low PA class for physical activity and non-smokers for smoking were set as the reference categories. Odds ratios <1.0 indicate that current smokers are less likely to have moderate or high PA status relatively to low.

Table 5. Adjusted odds ratios for the association between smoking volume (cigarettes/day) and physical activity status in current smokers.

		OR (95% CI)	p
Males:			
Moderate PA	≥21	0.40 (0.20 - 0.81)	0.011
	11-20	0.41 (0.22 - 0.78)	0.006
	0-10	1.00	
High PA	≥21	0.52 (0.18 - 1.49)	NS
	11-20	0.39 (0.15 - 1.06)	NS
	0-10	1.00	
Females:			
Moderate PA	≥21	0.36 (0.18 - 0.70)	0.003
	11-20	0.33 (0.20 - 0.56)	0.001
	0-10	1.00	
High PA	≥21	0.19 (0.04 - 0.94)	0.041
	11-20	0.34 (0.13 - 0.89)	0.028
	0-10	1.00	

Abbreviations as in Table 3. In MLR analysis, low PA class for physical activity and 0-10 cig/d for smoking volume were set as the reference categories. Odds ratios <1.0 indicate that heavy and moderate smokers are less likely to have moderate or high PA status relatively to low.

Discussion

This is the first study, to the best of our knowledge, to conduct a detailed examination of smoking behaviour, PA status and smoking-PA association in Greek young adults. According to our data, the prevalence of smoking and the rates of low PA were well above EU youth averages and disturbingly high for health science students. In addition, smoking was strongly and inversely associated with PA in both male and female young participants.

Smoking behaviour

At the end of 2005, smoking prevalence was estimated at 28.6% in the WHO European Region.[5] According to recent data, the overall trend remains and 29% of EU citizens are daily smokers, with smoking prevalence in the 27 EU countries ranging from 16% in Sweden to 42% in Greece.[6] European youth has the highest smoking prevalence rates in the world,[25] as 35% of young Europeans are smokers.[6] Our findings indicated a similar pattern of youth smoking prevalence in Greece (37.6%), in line with previously published data for Greek young adults.[16,26] Rates of heavy smoking were found to be considerably high in the present study (23.1%), well above the EU average for the general population (11%).[6] The mean age at smoking initiation was on the borderline between adolescence and adulthood (17.6 years), in accordance with the findings of others,[26-28] indicating that well educated young adults tend to start smoking later than other demographic young population groups.[5,25] This is an important issue, because smoking initiation at an earlier age is a strong predictor of smoking behaviour later in life and smoking continuation for a longer period of time.[23]

We found no significant differences in smoking prevalence between the sexes, in contrast to the usual sex-related differences in the general population reported in many studies.[5,6,25] However, our results are in agreement with those of others[26-28] that show a trend towards a narrowing of the difference in smoking prevalence between the sexes in well educated young Greek adults, mainly due to the increased smoking rates in females.

Educational level and smoking are in general inversely related.[5,23,25] However, our data, along with those of others,[26-28] indicate high smoking rates among Greek health science students, ranging from 31%,[27] 35.3%,[28] and 37.6% (present study) to 40.7%,[26] comparable to those seen in the general Greek population.[6] These smoking rates are well above average compared to many other countries,[29,30] indicating that smoking among health science students is also a very important public health concern for Greece. When one considers that this population includes individuals who will be helping guide health care policies a generation from now, these findings are especially disturbing.

Physical activity status

The increasing prevalence of physical inactivity and lack of exercise is a real public health challenge for Europe.[1,11] Recent data indicate that 39% of European citizens never do physical exercise and 14% never engage in PAs, with Greece topping the list of 27 EU countries.[14] The latter finding is in line with the results of other studies that rank Greece below average among many European countries in the prevalence of leisure time PA,[31] and above average in self-reported physical inactivity.[11,32,33]

Unfortunately, this problem is not confined to older people, but also applies to European young adults.[14,25,34] In the 2003 Eurobarometer, where IPAQ-short was also used,[34] 46.5% of young Europeans reported no vigorous PA and 38.6% had not done any moderate PA in the last seven days preceding the survey. Our results place Greek young adults at a level worse than the EU averages: 45.4% were insufficiently active, 56.4% reported zero vigorous PA and

49.7% zero moderate PA. The respective European averages in the general population are 31.3%, 36.8% and 40.6%.[21] Our findings are comparable with those of others who reported high rates (>45%) of low PA[28] or physical inactivity[18,19,35] among Greek university students. These rates are similar to those for the general Greek population[14,34] and altogether do not seem to confirm in Greek youth the positive relation between educational level and PA found elsewhere.[23,35,36] Regarding sex-related differences, the present data are in line with many others, inasmuch as young men tend to be more physically active than young women.[14,18,19,24,35,36]

Smoking – PA association in young adults

The inverse relation between smoking and physical fitness in young adults is well documented by a plethora of earlier[37] and more recent[17] studies. However, the association between smoking and PA is somewhat inconsistent. Most research in adults shows an inverse association between these factors, but this relationship is less pronounced in young adults and adolescents.[23] Our data indicated that young non-smokers were significantly more physically active compared to smokers. In addition, smoking reduced the odds of participating in both moderate and high intensity PAs. Our findings are in agreement with those of others who reported significant inverse associations between smoking and PA in adolescents[35,36,38-40] and young adults.[18,35,37,41,42] However, positive or non-significant correlations were found elsewhere.[23,24] In the present study, the inverted smoking-PA association was stronger in males. In contrast, according to the review by Kaczynski et al,[23] in most studies where a negative smoking-PA relationship was found, it was more pronounced in females.

There have been several hypotheses proposed to explain the inverse smoking-PA association, citing mainly psychological, behavioural and physiological factors. Young non-smokers and exercisers have a better perception of their health,[39,41] follow a healthier diet,[40,41] and have a greater awareness of the health consequences of smoking.[28,38] These findings, along with the beneficial effect of PA on depression[23,36] and emotional function,[41] and the greater self-confidence derived from participation in PAs,[38,42] support the hypothesis that PA may help deter young people from smoking.[35,36,42] In addition, health behaviours usually cluster;[23] that is, involvement in one positive behaviour (PA) increases the likelihood of involvement in another (non-smoking). Moreover, the ability of smokers to engage in PAs and exercise may be impaired by their reduced cardio-respiratory fitness.[17,23,37] Finally, it has been postulated that sedentary young adults (especially females) may start or continue smoking as a weight-control strategy.[4,23,42,43] However, this was not evident in our study, or in others,[28] as body weight and BMI were not associated with smoking in either sex.

Very few studies have examined the interrelation between smoking volume and PA in young smokers. According to our results, smoking volume was in general significantly inversely associated with PA. However, we did not find the dose-response relationship between levels of smoking and levels of PA that has been reported by others.[35]

Strengths and limitations

The random selection of the subjects from a well-defined and homogeneous target population, the effort to control for potential confounders, such as age, BMI, health and educational status, and the high participation rate added strength to the results of this study. Although the institutions that participated were not randomly selected, five of the 11 medical and physical therapy schools of Greece's higher education system were involved in the present study. On the other hand, there are certain limitations that have to be mentioned. Generalisation of our findings from a sample of health science students to all Greek young adults would be ill-advised. Therefore, it remains necessary to extend the study of the smoking-PA association to other demographic subgroups. It can be argued that it is preferable to validate smoking status biochemically rather than using formal questionnaires. However, agreement between cotinine measurement and self-reported smoking behaviour has been found to be higher than 90% among young adults.[38] Moreover, standardised questionnaires are widely used in the vast majority of large scale smoking-related studies.

Conclusion

According to the findings of this study, Greek health science students include a large percentage of sedentary and daily smokers. Both smoking and smoking volume were inversely associated with PA in this sample of Greek young adults, implying that participation in PAs may have a protective role against

smoking. Future research is needed to examine further the prevalence of smoking and physical inactivity in young adults and to elucidate the possible mechanisms through which these two very important risk factors are interrelated. This is particularly important for young health science students, since it will be their task to lead and implement the lifestyle change interventions needed to increase participation in PAs and exercise and build smoking prevention-cessation policies.

Acknowledgements

We acknowledge the contribution of Nicolaos Galgos, (University of Ioannina Medical School, Physiology Laboratory), and Vasilis Pliatsikas and Lefteris Chairetakis (physical therapists) for their assistance in the IPAQ-Gr administration. We also acknowledge the contribution of Serafim Nanas, Associate Professor of Athens University Medical School.

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