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Prevalence and determinants of physical activity and lifestyle in relation to obesity among schoolchildren in Israel

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Abstract

Objective: To describe the relationships between physical activity, lifestyle determinants and obesity in adolescent Israeli schoolchildren.
Design and setting: Cross-sectional survey.
Subjects: The MABAT Youth Survey was a nationally representative, school-based study of youth in grades 7 to 12 (ages 11–19 years).
Methods: Self-administered questionnaires assessed health behaviours and anthropometric indices were measured. Logistic regression analysis was used to examine the associations between obesity, physical activity, socio-economic status and other lifestyle habits. One-way ANOVA was used to determine mean physical activity levels (MET values) by BMI categories.
Results: The prevalence of overweight was 13–15% and of obesity 4–9% depending on gender and ethnicity, and was higher among the non-Jewish sectors. Thirty-six per cent and 57% of Jewish girls and boys, and 40% and 58% of non-Jewish girls and boys, respectively, were optimally active. Boys from low socio-economic schools and those who slept for less than 6 h at night were less active. Girls from middle school were found to be 53% more optimally physically active among Jews, and 89% more among non-Jews, compared with girls from high school ($P = 0{\cdot}001$); girls with less educated parents were also less physically active. No clear relationship was found between the level of obesity and physical activity.
Conclusions: Physical inactivity was strongly related to gender, age, social status, sleeping habits, hookah smoking, and parental educational status. Education and intervention programmes should focus on these risk factors.

Keywords
Optimal physical activity
Body mass index
Obesity
Schoolchildren
Sleep
Parental education

While the wide range of health benefits of physical activity is undisputed in both adults and children, there is a declining trend in physical activity, particularly in developed countries. This has obvious effects on efforts to counteract the obesity pandemic. According to the WHO 2004 report, at least 60% of the world's population fails to achieve the minimum recommendation of 30 min of moderate-intensity physical activity daily[1]. Data from the USA indicate that 61·5% of children aged 9–13 years do not participate in any organized physical activity during non-school hours and 22·6% do not engage in any free-time (leisure-time) physical activity[2].

Based on the 1996 WHO report, the level of leisure-time physical activity in the Israeli population is low with about 14% of the working population reporting participation in leisure-time physical activity more than once weekly[3]. In a national survey of time utilization and lifestyle in Israel conducted in 1991–2, 20% of the population aged 14 years and over participated in leisure-time activity more than once per week (24·6% of males and 16·5% of females), which was found to be higher among young people (38%) than adults (19%)[3]. From a public health perspective it is important to determine the level of physical activity and its determinants in order to provide a theoretical basis for the development of appropriate policies and programmes to enhance health and prevent the many complications attending physical inactivity, especially obesity. Intervention programmes should begin as early as possible and information on health behaviours among children is essential. Since there are many cultural determinants to lifestyle, the Israeli population offers an instructive example on how these may affect health behaviours.

The Israel Ministry of Health performed a national survey among middle- and high-school children, to study

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health and nutrition status and health behaviours among 11–19-year-olds. Using these data, the present paper describes the sociodemographic distribution of optimal level of physical activity and explores the interrelationships between gender, age, socio-economic status (SES), lifestyle habits and anthropometric measurements (obesity) in relation to participation in physical activity.

Research methods and procedures

Survey population, design and sampling frame

The study population included 6274 youth enrolled in the MABAT Youth Survey (First Israeli National Health and Nutrition Survey in 7th–12th grade students, 2003–2004), a cross-sectional, nationally representative, school-based study of youth in grades 7 to 12 (ages 11–19 years). The survey was undertaken from April 2003 to March 2004. Data were collected from two school year groups such that the mean age of pupils was 13·4 years for middle schools (grades 7–9) and 16·0 years for high schools (grades 10–12). The MABAT Youth Survey included both Jewish and non-Jewish (93·4% Arabs and Druse), religious and non-religious schools. Schools from the Haredi (ultra orthodox) sector were not included, and nor were independent, private or boarding schools.

Sample size

The sample size was calculated by assuming that 40% of students consumed 30% or more of their daily energy intake from fat, which would give statistically significant information with power of 80% and allowing for a 95% confidence interval. This 40% prevalence was found to be similar to the prevalence of optimal level of physical activity, preserving the power of the test. Overall, a sample size of 369 pupils in each category (subgroup) was used. With an additional 20% over-sampling, the country-wide sample size was 6760. The sampling procedures are described fully elsewhere[4].

Study variables

Type, frequency and duration of physical activity, and physical inactivity (television/video viewing or listening to music, talking on telephone, working on computer), smoking data, age and ethnicity were determined from self-reported data using self-administered questionnaires whereas level of SES was taken from the Ministry of Education classification of the welfare level of schools based on location. Height (with a coil-spring tape) and weight (with portable analogue scale) were measured by a trained person.

Composite variables

BMI

BMI was calculated by dividing weight by the square of height (kg/m^2). For the purpose of comparison BMI was categorized based on the age- and sex-specific cut-off values of the Centers for Disease Control and Prevention (CDC)/National Center for Health Statistics 2000 growth charts. The categories were underweight (<5th percentile), normal (5th to 85th percentile), overweight (85th to 95th percentile) and obese (>95th percentile). For multivariate analysis, BMI was classified as obese (>95th percentile) and non-obese (≤95th percentile)[5].

Level of physical activity

Optimum level of physical activity was defined as any moderate and vigorous level of physical activity which adds up to 60 min/d for four or more days a week as is recommended for schoolchildren by the CDC[6]. Light physical activities, i.e. walking, playing musical instruments and gardening, were excluded from the above definition.

MET calculations

Each type of activity was given a MET (metabolic energy equivalent task) score using the compendium of Ainsworth *et al.*[7]. MET-h were computed by multiplying the MET score by the hours performed at each activity, which was again multiplied by the frequency of the activity to obtain MET-h/week. For children involved in more than one activity, the sum of each activity's MET-h/week was taken as the total MET-h/week.

Classification of intensity of physical activity

A modified Borg perceived exertion scale[8] was used to classify the intensity of physical activity based on perceived difficulty of exercise: light (if the subject reported the level of difficulty of the exercise as 'light' in all activities); moderate (if the subject reported the level of difficulty of the activity as 'moderate' at least in one of the main activities); and vigorous (if the subject reported as the level of difficulty as 'difficult' in at least in one of the main activities).

Physical inactivity

Time spent on television and video viewing and listening to music was categorized as <2 h or ≥2 h, based on the recommendations of the American Academy of Pediatrics Committee on Public Education[9]. Although there are no data on recommended duration of working at the computer and talking on the telephone, we classified these activities similar to that for watching television/videos.

Statistical analyses

All statistical analyses were performed using the Statistical Package for the Social Sciences statistical software package version 12 (SPSS Inc., Chicago, IL, USA). The χ^2 test and the crude odds ratio were used to compare prevalence rates of optimal levels of physical activity. Differences in mean MET-h/week values were determined using one-way pairwise ANOVA and the Scheffe *post hoc* procedure

significant at the 5% level. The nature of the MABAT questionnaire and data collection was such that the answers were best summarized as dichotomous distributions. This was because most of the answers were not continuous variables, but rather in four or five categories of frequency choice and not simple numerical answers. Examples of this are, for hours viewing television: up to half an hour/half an hour to two hours/more than two hours/not at all, and similarly for smoking and alcohol habits. In the logistic regression analyses, binary logistic regression was used to examine the association between SES, lifestyle habits, BMI classification and level of physical activity (Tables 3), with the level of physical activity acting as the dependent variable. Dummy variables were created to compute odds ratios for these factors. In all analyses, odds ratios and associated 95% confidence intervals are presented for each level of the lifestyle variable in comparison with the referent level. For each independent variable the odds ratio was adjusted for all of the other variables included in the model.

Because lifestyle, anthropometric and physical activity data were missing from some subjects, odds ratios were determined for only 76·5% of Jewish boys, 75·6% of non-Jewish boys, 76·8% of Jewish girls and 78·3% of-non Jewish girls included in the survey. Age, school level, SES and BMI values of subjects with missing values were not significantly different from those with no missing values ($P > 0·05$).

Response rate

The response rate for the schools was 81·4% for the Jewish schools and 96·4% for Arab schools. From the Jewish sector 85·7% of eligible students responded while 94·0% took part in the survey from the Arab sector. A comparison of health parameters and risk behaviour carried out between the questionnaires of those present and those absent did not reveal any differences. There was no way of checking those students who were present but refused to participate. Differences between schools that agreed to participate and those that did not were also examined. In the Jewish sector, seventeen schools refused to take part. They were more likely to be from the state religious stream (59% among those refusing, 48% among schools surveyed). Similarly, the average welfare level among the schools refusing was 4, while among the participating schools the average was 6. Thus, schools that refused were generally of a higher socio-economic classification.

Validity of questionnaire

The MABAT youth questionnaires are similar, although not identical, to other self-reporting questionnaires that have been used and validated in other large-scale epidemiological studies among adults and adolescents[10–13]. However, they have yet to be evaluated for use among younger children.

Results

A total of 6274 children were enrolled in the study, of whom 55·1% (3458) were girls while 44·9% (2816) were boys. Demographic, BMI and lifestyle characteristics of the participants are shown in Tables 1 and 2.

Among the Jewish students, 12·8% of the boys and 12·0% of girls were found to be overweight (BMI between 85th and 95th percentile) compared with 13·3% of boys and 15·2% of girls among the non-Jewish population. The prevalence of obesity was found to be higher among Jewish boys than Jewish girls (6·8% *v.* 3·7%), and was 9·3% and 5·1% among non-Jewish boys and girls, respectively.

Table 1 Background characteristics and anthropometric measurements of study subjects, Israel, 2003–2004

		Boys		Girls	
Variable		Mean or *n*	SD or %	Mean or *n*	SD or %
Mean (SD) age (years)†	Jew	14·48	1·73	14·63	1·65
	Non-Jew	14·78	1·54	14·89	1·54
No. (%) of higher social class (level 1–5)	Jew	1908	57·0	2378	49·7
	Non-Jew	816	46·8	1019	47·5
No. (%) at high school	Jew	1916	43·1	2378	48·7
	Non-Jew	822	47·1	1031	55·7
Mean (SD) BMI (kg/m^2)‡	Jew	20·76	3·62	20·85	3·46
	Non-Jew	21·30	4·05	21·48	3·64
No. (%) according to BMI classification					
>5th percentile	Jew	101	5·9	87	4·2
	Non-Jew	35	4·5	29	3·0
Between 5th and 85th percentile	Jew	1287	74·6	1666	80·2
	Non-Jew	562	72·8	739	76·7
Between 85th and 95th percentile	Jew	220	12·8	249	12·0
	Non-Jew	103	13·3	147	15·2
>95th percentile	Jew	117	6·8	76	3·7
	Non-Jew	72	9·3	49	5·1

†Number of observations for age: 1916 in Jewish boys, 2378 in Jewish girls, 773 in non-Jewish boys, 1031 in non-Jewish girls.
‡Number of observations for BMI: 1725 in Jewish boys, 2078 in Jewish girls, 821 in non-Jewish boys, 964 in non-Jewish girls.

Table 2 Physical and recreational activity of study subjects, Israel, 2003–2004

Variable		Boys		Girls	
		Mean or *n*	SD or %	Mean or *n*	SD or %
No. (%) according to intensity level of physical activity					
Light	Jew	157	9·2	344	16·3
	Non-Jew	102	14·6	125	13·5
Moderate	Jew	986	57·7	1067	50·7
	Non-Jew	230	33·0	319	34·5
Vigorous	Jew	567	33·2	693	32·9
	Non-Jew	366	52·4	480	51·9
Mean (SD) MET index (MET-h/week)†	Jew	33·9	35·9	13·4	17·3
	Non-Jew	36·5	42·3	14·2	19·9
No. (%) watching television/videos and listening to music for ≥2 h/d	Jew	1862	42·4	2337	53·1
	Non-Jew	801	43·6	1031	58·8
No. (%) using computer for ≥2 h/d	Jew	1855	38·0	2333	22·3
	Non-Jew	798	34·5	1009	16·8
No. (%) according to hours of sleep per night					
<6 h	Jew	292	16·3	355	15·5
	Non-Jew	106	14·2	124	12·7
6–10 h	Jew	1438	80·2	1844	80·6
	Non-Jew	549	73·4	747	76·7
>10 h	Jew	63	3·5	90	3·9
	Non-Jew	93	12·4	103	10·6
No. (%) of cigarette smokers	Jew	1916	6·9	2333	5·6
	Non-Jew	805	6·5	984	1·8
Mean (SD) number of cigarettes smoked daily among current smokers‡	Jew	8·46	6·71	6·24	5·57
	Non-Jew	6·95	5·69	7·63	8·14
No. (%) of hookah smokers	Jew	1786	20·7	2222	11·3
	Non-Jew	784	17·3	938	3·1

MET, metabolic energy equivalent task.
†Number of observations for MET index: 1669 in Jewish boys, 2042 in Jewish girls, 649 in non-Jewish boys, 859 in non-Jewish girls.
‡Number of observations for number of cigarettes smoked daily: 130 in Jewish boys, 130 in Jewish girls, 52 in non-Jewish boys, 14 in non-Jewish girls.

The majority of Jewish boys (45·5%) reported involvement in ball games (including tennis, football, basketball and volleyball) followed by aerobic activities (30·9%) as their most common type of physical activity. However, most Jewish girls reported participating most commonly in either walking (31·7%) or aerobic activities (36·2%). Among non-Jews, more than 80% of boys reported participating in either ball games or aerobic activities as their most frequent activity, while girls reported mainly aerobic activities (50·9%) followed by walking (2·8%). The difference in the type of most frequent physical activity by ethnicity (Jews and non-Jews) was found to be significant in both boys ($\chi^2 = 26{\cdot}78$, $P = 0{\cdot}001$) and girls ($\chi^2 = 119{\cdot}4$, $P < 0{\cdot}001$).

Ethnicity was also found to be associated with intensity of physical activity. Non-Jews were more involved in physical activity of vigorous intensity, while Jews were more involved in moderate-intensity physical activity, in both boys and girls (see Table 2). This difference was also found to be very significant ($\chi^2 = 121{\cdot}07$, $P < 0{\cdot}001$ among boys; $\chi^2 = 99{\cdot}96$, $P < 0{\cdot}001$ among girls).

These data indicate that 36% and 57% of Jewish girls and boys respectively, and 40% and 58% of non-Jewish girls and boys respectively, were optimally active. Boys were more likely to be optimally active among both Jews (OR = 2·30; 95% CI 2·02, 2.63) and non-Jews (OR = 2·07; 95% CI 1·69, 2·51, adjusted for age) compared with girls.

Crude and adjusted odd ratios for optimal level of physical activity by different characteristics are presented in Table 3. Such description might lead to over-adjustment because of multi-collinearity and some underestimation of the relationships found. Comparison with the crude ratios provides a basis for comparison of such possible effects.

Obese non-Jewish boys were found to be 1·82 (95% CI 1·08, 3·06) times more likely to be active compared with non-obese non-Jewish boys, but this association disappeared when adjusted for all other variables. However, among Jewish and non-Jewish girls, no association was found. Running the regression equations with overweight (>85th percentile) did not affect the lack of relationship between overweight/obesity and physical activity (data not shown). Another assessment of activity was performed using MET-h/week. When mean MET-h/week values were compared in BMI categories using one-way ANOVA and the Scheffe *post hoc* procedure, there were no significant differences among boys or non-Jewish girls. However, there was a significant difference among Jewish girls wherein underweight girls (BMI < 5th percentile) were significantly less active than obese girls (BMI > 95th percentile) (Table 4).

Lower level of parental education (high school completed or less) was associated with lower level of physical activity among Jewish girls, with an odds ratio of 0·69 (95% CI 0·58, 0·84) at crude level when compared with

Table 3 Crude and adjusted† odds ratios (95 % confidence interval) of being optimally physically active by gender, ethnicity and selected lifestyle factors among schoolchildren, Israel, 2003–2004

		Boys				Girls			
		Crude		Adjusted		Crude		Adjusted	
Ethnicity/variable	Outcome category (reference category)	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Jews									
Father's education	High school or less (university/college)	0·99	0·82, 1·21	0·98	0·75, 1·29	0·69	0·58, 0·84	0·74	0·58, 0·96
Mother's education	High school or less (university/college)	1·11	0·91, 1·35	1·15	0·87, 1·50	0·80	0·67, 0·96	0·96	0·75, 1·23
Total hours of sleep per night	<6 (≥6)	0·56	0·43, 0·73	0·62	0·45, 0·85	0·89	0·69, 1.15	1·09	0·80, 1·47
Cigarette smoking	Smokers (non-smokers)	1·18	0·79, 1·76	0·73	0·44, 1·20	1·26	0·83, 1·92	1·24	0·72, 2·12
Hookah smoking	Smokers (non-smokers)	0·78	0·61, 1·00	0·87	0·64, 1·18	0·91	0·67, 1·23	0·96	0·66, 1·40
Time watching television/videos or listening to music	<2 h/d (≥2 h/d)	1·21	0·99, 1·47	1·15	0·91, 1·45	1·01	0·84, 1·21	1·11	0·89, 1·36
Obese (>95th percentile)	Yes (no)	1·13	0·76, 1·67	1·14	0·74, 1·78	0·72	0·44, 1·16	0·86	0·86, 1·50
Alcohol consumption in past month	Yes (no)	0·82	0·68, 0·99	0·83	0·65, 1·05	0·93	0·77, 1·13	0·96	0·76, 1·21
Social status	High social class (low social class)	1·29	1·06, 1·56	1·30	1·02, 1·65	1·06	0·88, 1·26	1·01	0·82, 1·24
School level	Middle school (high school)	1·36	1·13, 1·66	1·15	0·85, 1·47	1·53	1·28, 1·84	1·53	1·23, 1·91
Non-Jews									
Father's education	High school or less (university/college)	0·84	0·61, 1·15	0·92	0·61, 1·37	0·76	0·57, 1·01	0·91	0·64, 1·31
Mother's education	High school or less (university/college)	0·86	0·62, 1·21	0·86	0·56, 1·33	0·50	0·37, 0·68	0·46	0·31, 0·67
Total hours of sleep per night	<6 (≥6)	0·82	0·53, 1·27	0·66	0·39, 1·11	1·38	0·92, 2·08	1·40	0·85, 2·31
Cigarette smoking	Smokers (non-smokers)	1·65	0·89, 3·07	1·49	0·67, 3·32	1·10	0·36, 3·38	0·54	0·09, 3·26
Hookah smoking	Smokers (non-smokers)	0·64	0·43, 0·96	0·59	0·35, 1·01	0·88	0·38, 2·03	0·52	0·12, 2·15
Time watching television/videos or listening to music	<2 h/d (≥2 h/d)	0·78	0·57, 1·05	0·77	0·54, 1·12	0·89	0·68, 1·16	0·92	0·67, 1·26
Obese (>95th percentile)	Yes (no)	1·82	1·08, 3·06	1·39	0·77, 2·54	0·85	0·46, 1·57	0·88	0·44, 1·78
Alcohol consumption in past month	Yes (no)	1·13	0·79, 1·62	1·21	0·74, 2·00	1·28	0·81, 2·03	1·68	0·89, 3·14
Social status	High social class (low social class)	1·01	0·75, 1·36	1·09	0·76, 1·59	1·01	0·77, 1·32	0·74	0·54, 1·04
School level	Middle school (high school)	0·91	0·67, 1·23	0·95	0·64, 1·42	1·39	1·07, 1·82	1·89	1·36, 2·63

†Adjusted for all other variables included in the table.

Table 4 Mean MET-h/week in different BMI categories by sex and ethnicity among schoolchildren, Israel, 2003–2004

Gender/ethnicity	BMI percentile	*n*	Mean	SD	*P*
Boys					
Jew	<5th	85	26·1	28·0	
	5th–85th	1138	34·9	35·3	
	85th–95th	195	34·0	33·0	
	>95th	105	30·4	34·2	
	Total	1523	34·0	34·6	0·10
Non-Jew	<5th	31	27·0	24·4	
	5th–85th	441	36·3	42·9	
	85th–95th	86	34·1	31·1	
	>95th	54	42·6	59·0	
	Total	612	36·0	42·4	0·40
Girls					
Jew	<5th	72	8·3*	8·5	
	5th–85th	1429	13·1	17·6	
	85th–95th	220	14·1	16·1	
	>95th	69	17·7*	16·8	
	Total	1790	13·2	17·2	0·01
Non-Jew	<5th	24	9·3	11·7	
	5th–85th	611	13·8	18·2	
	85th–95th	129	16·5	26·8	
	>95th	43	18·8	27·5	
	Total	807	14·4	20·3	0·13

MET, metabolic energy equivalent task.
*Significantly different categories using the Scheffe *post hoc* test.

children with higher father's educational status. This association remained significant when adjusted for all other variables included in the logistic regression model (OR = 0·74; 95% CI 0·58, 0·96). However, there was no association among Jewish boys or non-Jewish girls and boys. Similarly, lower maternal educational level was associated with a lower prevalence of optimal level of physical activity among both Jewish girls (OR = 0·80; 95% CI 0·67, 0·96) and non-Jewish girls (OR = 0·50; 95% CI 0·37, 0·68) at crude level. However, this association remained significant only among non-Jewish girls when adjusted for other variables included in the model (OR = 0·46; 95% CI 0·31, 0·67). There was no association detected for boys.

Jewish boys who habitually slept for <6 h per night were found to be 0·56 (95% CI 0·43, 0·73) times less likely to be optimally active compared with those who slept longer. This association was not found among the other sex and ethnic groupings.

Jewish and non-Jewish boys who smoked hookah were found to be 0·78 (95% CI 0·61, 1·00) and 0·64 (95% CI 0·43, 0·96) times less likely to be optimally active compared with their non hookah-smoking counterparts. However, this association disappeared among Jewish boys and just failed to be significant among non-Jewish boys (OR = 0·59; 95% CI 0·35, 1·01) when adjusted for all other variables included in the logistic regression model.

History of alcohol consumption one month prior to interview was negatively associated with optimal level of physical activity among Jewish boys (OR = 0·82; 95% CI 0·68, 0·99) only at the crude level.

Jewish boys from lower social status schools were found to be 1·29 (95% CI 1·06, 1·56) times more likely to be optimally active than Jewish boys from higher SES schools, which stayed significant when adjusted for all other variables (OR = 1·30; 95% CI 1·02, 1·65).

Middle-school students were more likely to be optimally active than high-school students among Jewish boys (OR = 1·36; 95% CI 1·13, 1·66) and girls (OR = 1·53; 95% CI 1·28, 1·84) and non-Jewish girls (OR = 1·39; 95% CI 1·07, 1·82). However, this association stayed significant only among girls (OR = 1·53; 95% CI 1·23, 1·91 among Jews, OR = 1·89; 95% CI 1·36, 2·63 among non-Jews) when adjusted for all other variables included in the model.

However, being a cigarette smoker and watching television/videos or listening to music for ≥2 h/d had no significant effect on level of optimal physical activity (Table 3).

Discussion

Sociodemographic characteristics and physical activity

Although the prevalence of optimal level of physical activity (57–58% in boys, 36–38% in girls) is not satisfactory, it still is higher than in other developed countries such as the USA[2]. Age-adjusted logistic regression analysis showed boys twice as likely to be optimally active compared with girls. This gender difference has also been observed in many other studies which showed more boys reporting higher levels of physical activity than girls[13–16]. These findings could be explained by less social desirability of physical activity for girls *v.* boys and may be due to less accessibility of structured activity for girls, which need further investigation.

In addition to gender, age demonstrated a relatively consistent pattern, with older (high school) children reporting less physical activity than younger children, although once again this relationship seemed more pronounced among females. Such decline in the prevalence of optimal physical activities with increasing age was also found in other studies among both boys and girls[17,18] and among girls[19], although no studies have been done investigating the behavioural impact of age on physical activity.

Ethnicity is also an additional factor presumed to influence physical activity among children in terms of self-reported activity[13,15,16]. Our findings also showed that Jews were less likely to be classified as optimally active compared with non-Jews, with age-, sex- and social class-adjusted OR of 0·86 (95% CI 0·76, 0·97).

Social class was found to have a significant positive association with optimal level of physical activity among Jewish boys. This might be due to the difference in accessibility to facilities between schools or children of high social class. Similar findings were also reported among Scottish schoolchildren, where adolescents from lower SES groups consistently reported lower levels of

vigorous physical activity than those from higher SES groups and the differences were more pronounced among girls[20].

While activity among Jewish girls was associated more with their father's educational status, activity among non-Jewish girls was associated more with their mother's educational status. This difference could be explained by the traditional difference in relationships between parents and girls among Jews and non-Jews.

Relationship between overweight and physical activity

There was no association seen between obesity and level of physical activity both at the crude and the adjusted level, except among non-Jewish girls where there was a positive association at the crude level. This lack of association between obesity and level of physical activity is supported by the findings from a similar study utilizing a cross-sectional analysis of a national sample in 14- to 16-year-old girls[21]. Moreover, several other national studies[10,22], one trial[23] and two other studies[24,25] found no relationship between physical activity and body composition, including obesity.

The associations (or lack of them) found in the present study could be explained by the cross-sectional nature of the study rendering it impossible to determine which comes first: the exercise or the overweight. Another potential explanation could be differential over-reporting of physical activity by obese or overweight children in a manner similar to their under-reporting of food consumption[26,27], even to the extent of reversing the positive association between high fat intake and obesity[28].

Sedentary lifestyle and physical activity

Although many studies have found a negative association between level of physical activity and time spent watching television, in Australian adults[29] as well as among US children[10,22,30,31], the present study showed no association between time spent viewing television or videos or listening to music with levels of physical activity when adjusted for all other independent variables. This might be partially due to the adding together of the time spent watching television with that spent listening to music, which might in fact not reflect physical inactivity. Similarly, there was no significant association between the time spent at the computer or talking on the telephone.

Duration of sleep and level of physical activity

Previous studies have shown a negative association between obesity and length of sleep among children[32,33], but there has been no study on the association between sleep and physical activity. The above two studies put shorter duration of sleep as a risk factor for obesity. The present study too showed less duration of sleep to be associated with a low prevalence of optimal physical activity among Jewish boys, with a non-significant similar pattern seen among Jewish girls and non-Jewish boys too. However, owing to the design of our study, at this stage it is impossible to determine whether inactivity causes lack of sleep or vice versa; this needs to be studied in prospective research in the future.

Cigarette smoking and physical activity

The negative impact of smoking on physical activity among adults is well documented[34,35], but there have been few studies among children and adolescents. In our study, hookah smoking (also called 'narghile' or water pipe, which has similar composition to cigarettes except for higher levels of nicotine and carbon monoxide in the hookah[36]) but not cigarette smoking was found to be associated with less optimal level of physical activity among boys, although it was significant only among non-Jewish boys. Lack of association between cigarette smoking and physical activity might be due to the low prevalence of cigarette smoking or the higher dose of nicotine in hookah as compared with cigarettes, or other confounding factors like use of additional drugs such as hashish. This was supported by a study done in Israel where 6% of the respondents in schools reported adding drugs or alcohol to the tobacco[36].

Alcohol consumption and physical activity

There is no consensus on the association between alcohol consumption and physical activity. A study done among college students in the USA showed a positive association between binge drinking and participation in physical activity[37]. Our results show that although there was a negative association between alcohol consumption and level of physical activity among Jewish boys at the crude level, history of alcohol consumption was found to have no association with optimal level of physical activity when adjusted for other variables. This could due to the fact that the effect of alcohol depends on the dose, or possibly that these children do not consume large amounts of alcohol.

Conclusions

Overall, gender and age were the most significant factors contributing to differences in physical activity participation. Females were less active than males, and activity levels decreased with age, which was reflected by the lower prevalence of optimal level of physical activity among high-school *v.* middle-school students. Moreover, sleep duration, parental educational status and social status were found to be positively associated with prevalence of optimal level of physical activity, while level of alcohol consumption and hookah smoking were found to be negatively associated.

Limitations of the study

The findings in the present study are subject to a number of limitations. First, the MABAT Youth Survey is a

school-based survey and does not include children out of school or children in private or independent schools. Second, data were self-reported and subject to error, including respondent over-reporting of socially desirable responses (social desirability response bias). Third, duration and frequency of physical activity might not be reliable because it could be difficult for children in middle schools to understand the questions and be able to aggregate minutes of physical activity accurately. In addition, there may be a problem in assessing average physical activity when there may be seasonal variations from the vagaries of the weather. Fourth, it is difficult to rely on the adjusted odds ratio since many of the variables are interrelated to each other, underestimating associations.

Recommendations

Based on our findings, we recommend promotion and advocacy of physical activity to focus mainly on girls in general, high-school students (particularly girls), Jewish boys from lower social class schools, non-Jewish girls from higher social class schools, and girls according to parent's education. Furthermore, smoking (including hookah) needs to be discouraged among school students (particularly among non-Jewish boys) for reasons of general health promotion and because it decreases physical fitness.

Means of doing this could include comprehensive physical education provided at school – an ideal way to reach and encourage activity and develop active lifestyles among children. In addition, interventions such as providing incentives e.g. for subsidized memberships/entry fees for sports facilities, increased emphasis on sport at school, encouragement to walk at all opportunities and specially dedicated cycling paths, could all assist in improving levels of activity, particularly among the economically disadvantaged.

Moreover, we recommend undertaking qualitative research among optimally active children to find their enabling factors ('positive deviance') through which to help promote physical activity in their less active peers. Further studies on hookah smoking and sleep duration in relation to physical activity are also warranted.

We also recommend research to test the social desirability bias by taking a sub-sample and comparing subjective fitness assessment (questionnaires) with objective measures of exercise tolerance. This can be done using the Harvard step test to measure the fitness of the child[38], using doubly labelled water to measure energy expenditure[39] or using pedometers to measure level of activity over a specified period of time[40].

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