

ORIGINAL RESEARCH

# Secular Trends in Age at Menarche, Smoking, and Oral Contraceptive Use Among Israeli Girls

Gabriel Chodick, PhD, MHA, Michael Huerta, MD, MPH, Ran D. Balicer, MD, Nadav Davidovitch, MD, MPH, Itamar Grotto, MD, MPH

*Suggested citation for this article:* Chodick G, Huerta M, Balicer RD, Davidovitch N, Grotto I. Secular trends in age at menarche, smoking, and oral contraceptive use among Israeli girls. *Prev Chronic Dis* [serial online]. 2005 Apr [date cited]. Available from: URL: [http://www.cdc.gov/pcd/issues/2005/apr/04\\_0063.htm](http://www.cdc.gov/pcd/issues/2005/apr/04_0063.htm).

PEER REVIEWED

## Abstract

### Introduction

The improved nutrition and socioeconomic status of the population in industrialized countries has resulted in a decrease in the mean age at menarche. This trend raises the question of whether cigarette smoking and the use of oral contraceptives, health behaviors often adopted during adolescence, may also be starting at a younger age. Cigarette smoking and use of oral contraceptives are a public health concern because they pose an increased risk for development of chronic diseases, particularly in combination. This study was designed to identify secular trends in age at menarche, at first cigarette, and at first use of oral contraceptives among a large population-based sample of young Israeli women and to assess whether these trends are associated with sociodemographic factors.

### Methods

A systematic, population-based survey used data obtained from female recruits to the Israel Defense Force from 1986 to 2000. During the study period, 11,392 questionnaires were collected from Jewish women aged 18 to 19 years. Participants were interviewed concerning geo-

graphic origin and level of education, father's geographic origin and level of education, current smoking status, use of oral contraceptives, and recalled age at first menstruation, first cigarette, and first use of oral contraceptives.

### Results

Reported mean age ( $\pm$  SD) at menarche showed a monotonic trend of decreasing over time, from 13.41 ( $\pm$  1.30) years for women born before 1970 to 13.03 ( $\pm$  1.28) years for those born after 1978 ( $P < .001$ ). Women born after 1978 were twice as likely to experience menarche by the age of 11 as those born prior to 1970 (odds ratio 2.0; 95% confidence interval, 1.41–2.82). Significant trends toward younger age at first use were observed for cigarettes and oral contraceptives.

### Conclusion

The trends of earlier age at menarche, first cigarette, and first use of oral contraceptives suggest health behaviors among young women that may herald increased chronic disease morbidity in the future. These trends indicate the need for further investigation and preventive measures aimed at this population.

## Introduction

The onset of puberty in women is marked by numerous changes, both physiological and behavioral, the most marked of which is the commencement of menstruation (1). The mean age at menarche reflects numerous health aspects of a population, including the timing of sexual maturation, growth and nutritional status, and environmental conditions (2). In the United States, the mean age

at menarche decreased from more than 14 years prior to 1900 (3) to less than 12.5 years currently (2), although racial differences in maturational timing have been observed consistently in nationally representative and clinical samples, across time and using different study designs (4,5). Recently published data on the incidence of breast cancer among a large cohort of French women provide further evidence that the overall risk of breast cancer increases with younger age at menarche. Among premenopausal women, those with a history of menarche at age 11 or younger were at increased risk for breast cancer when compared with those with menarcheal onset at age 15 or older (relative risk 1.52; 95% confidence interval [CI], 1.03–2.22) (6). Secular trends in the average age at menarche may, in fact, affect the future epidemiology of breast cancer.

Puberty is often accompanied by the adoption of new behaviors such as alcohol drinking, cigarette smoking, and the use of oral contraceptives (OC) for pregnancy prevention with the commencement of sexual activity. In addition to the well-established data on the risks to health from cigarette smoking, substantial data are available on the excessive risk for cardiovascular diseases among smokers who use OC (7). A recently published report on mortality among women who used OC reveals more than a doubled risk for death from all causes among heavy smokers (8). Thus, data on trends in onset of puberty and behavioral aspects of adolescence are important to public health policy makers. However, few data on age of menarche in Israel are currently available. No population-based survey has been undertaken on this issue; a single published cross-sectional study was conducted more than 20 years ago (9).

The objectives of this study were to describe secular trends in age at menarche, at first cigarette, and at initial use of OC among a large population-based sample of young Israeli women and to assess whether changes in these parameters over time are associated with sociodemographic factors.

## Methods

### Study population

The study population was derived from an ongoing large-scale prospective survey of health behavior and attitudes routinely administered among a fixed proportion of

Israel Defense Force (IDF) recruits. Because military service is mandatory in Israel, the survey provides a population-based sample of the young adult population, excluding ultra-Orthodox Jews and Arabs, who are largely exempted from service. The sampling process is systematic and is based on a predetermined combination of digits of the participant's serial number, as previously described (10,11). Ninety-five percent of all female study participants are aged 18 to 19 at inclusion. The present study targeted all females recruited from 1986, when questions on age at menarche were first introduced, through 2000.

### Data collection

Study subjects were asked to participate on the day of recruitment. Trained nurses from the IDF Health Surveillance Section interviewed participants. Participants were asked about their father's geographic origin (divided into two categories: West [i.e., Europe–America] or East [i.e., Asia–Africa]) and the extent of their own and their father's formal education and attainment of an academic degree. In addition, participants were asked about the age (rounded to the nearest half year) at the onset of menstruation, present smoking status (current smoker, past smoker, or never a smoker), age at onset of habitual smoking (defined as >1 cigarette/week), age at first OC use, and current status of OC use. The study and data collection were approved by the IDF Ethics Committee.

### Statistical analysis

Main outcomes (age at menarche, age at first cigarette, and age at first use of OC) were compared between birth cohorts using one-way analysis of variance after grouping the study population into five cohorts based on birth year (prior to 1970, 1970 to 1972, 1973 to 1975, 1976 to 1978, and after 1978).

To determine changes over time in age of menarche, data were initially analyzed by employing a simple linear regression model with age at menarche as the dependent variable and year of birth as the sole covariate. To investigate the possible influence of paternal sociodemographic background on the temporal trend in age at menarche, similar linear regression models were fitted, one for each category of the origin (West and East), age of initial smoking and smoking status at recruitment (current smoker, past smoker, and never a smoker), and father's years of

education (categorized into <12 years, 12 years, and >12 years of education).

To assess differences in age at menarche by birth cohort, a term for year of birth and background variables were included in a stepwise multivariate model, using age at menarche as the dependent variable. Analyses were carried out using standard statistical software (SPSS 11.0, Chicago, Ill).

**Results**

Data were available for 11,392 women, with a mean (± SD) age of 18.5 (± 0.37) years and a median of 18.47 years at recruitment. A trend of increasing education over time was recorded for subjects' fathers. Approximately 43.5% of the study participants were of western origin, with little variation over time (Table 1).

Reported mean age (± SD) at menarche showed a monotonic trend of decrease over time, from 13.41 (± 1.30) years for women born before 1970 (the earliest birth cohorts in the study population) to 13.03 (± 1.28) years for those born after 1978 (the latest birth cohorts in the study population) ( $P < .001$ ) (Table 2). The proportion of subjects reporting menarche at age 11 or earlier was 3.3% for women born before 1970, 4.0% for women born from 1970 to 1972, 4.9% for women born from 1973 to 1975, 5.2% for women born from 1976 to 1978, and 6.3% for women born after 1978. Women born after 1978 were twice as likely as those born before 1970 to have had an early menarche (odds ratio 2.0; 95% CI, 1.41–2.82).

The study data showed a significant increase over time in the proportion of recruits reporting having ever smoked (from 23.55% in the earliest birth cohort to 32.86% in the latest [ $P < .001$ ]) and in those reporting having ever used OC (from 25.49% in the earliest birth cohort to 31.24% in the latest [ $P < .001$ ]) (Figure). A significant downward trend was observed in mean age at first use of OC with sequential birth cohorts, from 17.49 (± 0.81) years in the earliest cohort to 17.14 (± 1.05) years in the latest cohort ( $P < .001$ ). A similar trend was present for age at first cigarette, with the mean age decreasing from 16.68 (± 1.30) years to 15.85 (± 1.36) years ( $P < .001$ ).

Regression modeling showed a negative association between the recruits' year of birth and their age at menar-

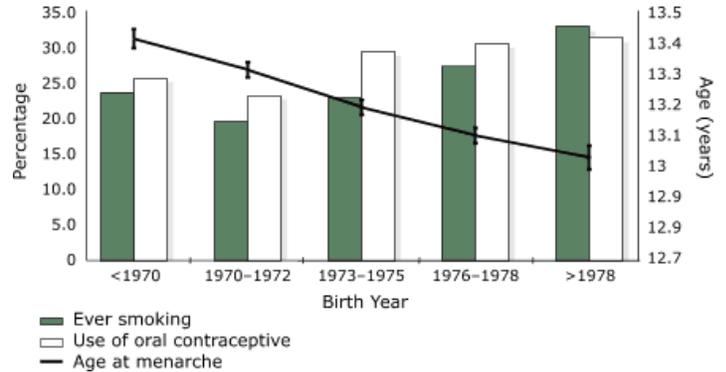


Figure. Trend for age at menarche ( $P < .001$ ) and proportion of recruits having ever smoked ( $P < .001$ ) or used oral contraceptives ( $P < .001$ ) among female Israeli army recruits (1986–2000), by birth year. The left axis refers to prevalence (%) of positive smoking history (green columns) and oral contraceptive use (white columns). The right axis refers to mean reported age in years at menarche.

che, indicating a downward temporal trend of 4.2 months per decade (95% CI, 3.6–5.0) in age at menarche. Comparison of regression coefficients between birth year and reported age at menarche shows similar results for women of western and eastern origins and for all categories of paternal education (Table 3). A tendency toward a stronger downward temporal trend was recorded among past smokers; however, this trend did not reach statistical significance. Year of birth was the sole factor that maintained a significant regression coefficient with age at menarche in a multivariate linear regression model that also included subject's origin, father's level of education, and smoking status.

**Discussion**

This population-based study of young Israeli women demonstrates a trend over time of decreasing age at menarche, as indicated by younger age at menarche among girls born between 1965 and 1981. These same birth cohorts were characterized by decreasing age at first cigarette and at first use of OC and by an increasing proportion of adolescent smoking and OC use.

Age at first menstruation has shown a decreasing secular trend in many populations (12-14). A recently published study of a nationally representative sample of U.S. girls shows that for 80% of girls in the United States, menarche occurs between 11.00 and 13.75 years of age,

The opinions expressed by authors contributing to this journal do not necessarily reflect the opinions of the U.S. Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention, or the authors' affiliated institutions. Use of trade names is for identification only and does not imply endorsement by any of the groups named above.

with a median of 12.43 years (2). Although our study data show a relatively older average age at menarche in comparison with the United States, a steeper trend of reduction over time was recorded. Although data from the United States suggest an overall drop of approximately 2.5 months during the period between the late 1960s and the early 1990s (15), our data indicate a decrease of 4.2 months per decade. Scandinavian studies have shown a trend toward younger age at menarche during the second half of the 20<sup>th</sup> century (16). A previous study undertaken in Israel in 1977 among a sample of 285 Jewish girls in grades three through eight (birth years 1969 and earlier) found a mean age of 13.29 ( $\pm$  0.45) years at menarche (9). This mean was nearly identical to that found in the current study among girls of comparable birth cohorts.

The ecologic association between age at menarche and age of first cigarette may have several possible explanations. Girls who are relatively physically mature for their age may associate with older adolescents and imitate their behavior (17). Menarche at younger age may present a serious psychological stressor, resulting in early smoking in addition to other unhealthy behaviors. Several studies have suggested that hormonal changes accompanying menarche may directly contribute to changes in behavior (18,19).

This population-based study has several strengths, such as systematic sampling, large sample size, and standardized data collection methods throughout the entire study period. Because young women with severe disease or disability are exempt from military service, study data are not affected by potential secular changes in the epidemiology of such diseases in the general population. Two limitations must be noted, however. Since ultra-Orthodox Jewish and Arab adolescents are exempt from military service, no conclusions pertaining to these minority groups can be drawn from the present study. Additionally, data collection for this study was based on recall of age at menarche at recruitment rather than recorded prospectively at time of onset. However, because menarche is an easily recognizable event that is well remembered by most women, any reporting errors are expected to be both small and nondifferential because the study participants were all of the same age at recruitment and data were obtained only a few years after menstruation commenced.

It is generally thought that improvement in socioeconomic conditions and overall health are the main contributing factors to the trend toward earlier sexual matu-

ration (20). Nonetheless, the mechanisms through which these changes occur are still unknown. Several hypotheses have been discussed in the literature, such as the "critical weight hypothesis" (21) and the leptin hypothesis (22). Other investigators have studied the role of estrogen-like substances in the environment on the timing of puberty (23). However, stabilization in the age of puberty onset over the last two decades, which has been observed in several countries (24,25), and studies finding that girls belonging to lower social strata showed a temporal trend toward reduction in the age at menarche (9,26,27) raise questions about the causality of these factors.

A recent cohort study of 17,032 women aged 25 to 39 who had used OC showed that death from all causes was more than twice as high in smokers (15 cigarettes per day) than in nonsmokers and that harmful effects were already apparent in women aged 35 to 44 (26). The age at which smoking begins has been shown to influence the total number of years of smoking (28), the number of cigarettes smoked per day in adulthood, and the likelihood of quitting (29), all of which affect the risk for developing smoking-attributable disease and disability (30).

The ongoing significant growth in the proportion of adolescent girls who smoke at an increasingly younger age, combined with the rise in OC use and increasingly younger ages at menarche and initial OC use, suggest a rise not only in the prevalence of exposure to these risk factors but also in the duration of exposure. This trend implies a serious public health problem, which may translate into increased future morbidity and mortality. Given the epidemiology of smoking initiation, more public health policy and programmatic attention should be aimed at early adolescence in order to prevent or delay adolescent cigarette smoking. This approach strongly supports the Centers for Disease Control and Prevention's "Guidelines for School Health Programs to Prevent Tobacco Use and Addiction," which call for tobacco-use prevention education in kindergarten through 12<sup>th</sup> grades (30). Health policy authorities should further investigate changes in health behavior among adolescents over time to evaluate the effectiveness of such intervention in the future.

## Author Information

Corresponding Author: Gabriel Chodick, PhD, MHA, Israel Defense Force Medical Corps, Army Health Branch,

Department of Epidemiology & Preventive Medicine, Sackler Faculty of Medicine, Tel-Aviv University, PO Box 39040, Ramat Aviv, Tel Aviv 69978, Israel. Telephone: 972-3-6409040. E-mail: hodik\_g@mac.org.il.

Author Affiliations: Michael Huerta, MD, MPH, Ran D. Balicer, MD, Nadav Davidovitch, MD, MPH, Itamar Grotto, MD, MPH, Israel Defense Force Medical Corps, Army Health Branch, Department of Epidemiology & Preventive Medicine, Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel.

## References

- Dewhurst J. *Female Puberty and its Abnormalities*. London: Churchill Livingstone; 1984.
- Chumlea WC, Schubert CM, Roche AF, Kulin HE, Lee PA, Himes JH, et al. Age at menarche and racial comparisons in US girls. *Pediatrics* 2003;111:110-3.
- Wyshak G, Frisch RE. Evidence for a secular trend in age of menarche. *N Engl J Med* 1982;306:1033-5.
- Harlan WR, Harlan EA, Grillo GP. Secondary sex characteristics of girls 12 to 17 years of age: the U.S. Health Examination Survey. *J Pediatr* 1980 Jun;96(6):1074-8.
- Kimm SY, Barton BA, Obarzanek E, McMahan RP, Sabry ZI, Waclawiw MA, et al. Racial divergence in adiposity during adolescence: the NHLBI Growth and Health Study. *Pediatrics* 2001;107:E34.
- Clavel-Chapelon F; E3N-EPIC Group. Differential effects of reproductive factors on the risk of pre- and postmenopausal breast cancer. Results from a large cohort of French women. *Br J Cancer* 2002;4:723-7.
- Burkman RT. Cardiovascular issues with oral contraceptives: evidenced-based medicine. *Int J Fertil Womens Med* 2000;45:166-74.
- Vessey M, Painter R, Yeates D. Mortality in relation to oral contraceptive use and cigarette smoking. *Lancet* 2003;362:185-91.
- Belmaker E. Sexual maturation of Jerusalem schoolgirls and its association with socio-economic factors and ethnic group. *Ann Hum Biol* 1982;9:321-8.
- Kark JD, Laor A. Cigarette smoking and educational level among young Israelis upon release from military service in 1988—a public health challenge. *Isr J Med Sci* 1992;28:33-7.
- Grotto I, Huerta M, Kark JD, Shpilberg O, Meyerovitch J. Relation of parental history of coronary heart disease to obesity in young adults. *Int J Obes Relat Metab Disord* 2003;27(3):362-8.
- Harper J, Collins JK. The secular trend in the age of menarche in Australian schoolgirls. *Aust Paediatr J* 1972;8:44-8.
- Maresh M. A forty-five year investigation for secular changes in physical maturation. *Am J Phys Anthropol* 1972;36:103-10.
- Tanner JM. Trend towards earlier menarche in London, Oslo, Copenhagen, the Netherlands and Hungary. *Nature* 1973;243:95-6.
- Anderson SE, Dallal GE, Must A. Relative weight and race influence average age at menarche: results from two nationally representative surveys of US girls studied 25 years apart. *Pediatrics* 2003;111:844-50.
- Helm P, Helm S. Decrease in menarcheal age from 1966 to 1983 in Denmark. *Acta Obstet Gynecol Scand* 1984;63:633-5.
- Brooks-Gunn J. Antecedents and consequences of variations in girls' maturational timing. *J Adolesc Health Care* 1988;9:365-73.
- Susman EJ, Nottelmann ED, Inoff-Germain G, Dorn LD, Chrousos GP. Hormonal influences on aspects of psychological development during adolescence. *J Adolesc Health Care* 1987;8:492-504.
- Warren MP, Brooks-Gunn J. Mood and behavior at adolescence: evidence for hormonal factors. *J Clin Endocrinol Metab* 1989;69:77-83.
- Hauspie RC, Vercauteren M, Susanne C. Secular changes in growth and maturation: an update. *Acta Paediatr Suppl* 1997;423:20-7.
- Frisch RE, Revelle R. Height and weight at menarche and a hypothesis of critical body weights and adolescent events. *Science* 1970;169:397-9.
- Clayton PT, Trueman JA. Leptin and puberty. *Arch Dis Child* 2000;83:1-4.
- Mazur W. Phytoestrogen content in foods. *Baillieres Clin Endocrinol Metab* 1998;12:729-42.
- Mul D, Fredriks AM, van Buuren S, Oostdijk W, Verloove-Vanhorick SP, Wit JM. Pubertal development in The Netherlands 1965-1997. *Pediatr Res* 2001;50:479-86.
- Liestol K, Rosenberg M. Height, weight and menarcheal age of schoolgirls in Oslo—an update. *Ann Hum Biol* 1995;22:199-205.
- Prebeg Z. Changes in growth patterns in Zagreb school children related to socioeconomic background over the period 1973-1991. *Ann Hum Biol* 1998;25:425-39.
- Junqueira Do Lago M, Faerstein E, De Souza Lopes C,

- Werneck GL; Pro-Saude Study (Rio de Janeiro, Brazil). Family socio-economic background modified secular trends in age at menarche: evidence from the Pro-Saude Study (Rio de Janeiro, Brazil). *Ann Hum Biol* 2003;30:347-52.
28. Escobedo LG, Marcus SE, Holtzman D, Giovino GA. Sports participation, age at smoking initiation, and the risk of smoking among US high school students. *JAMA* 1993 17;269:1391-5.
29. Breslau N, Fenn N, Peterson EL. Early smoking initiation and nicotine dependence in a cohort of young adults. *Drug Alcohol Depend* 1993;33:129-37.
30. Centers for Disease Control and Prevention. Guidelines for school health programs to prevent tobacco use and addiction. *MMWR Recomm Rep*. 1994 Feb 25;43(RR-2):1-18.

Tables

Table 1. Demographic Characteristics of Female Israeli Army Recruits, 1986–2000, by Birth Year

Birth year	n	Age in years at recruitment	Father's years of education	Origin <sup>a</sup>	
		Mean (SD)	Mean (SD)	West	East
<1970	1867	18.58 (1.16)	11.92 (3.33)	42.4%	57.6%
1970-1972	2830	18.50 (0.35)	12.05 (3.11)	42.8%	57.2%
1973-1975	3029	18.53 (0.41)	12.46 (3.21)	43.8%	56.2%
1976-1978	2537	18.55 (0.38)	12.87 (3.18)	45.5%	54.5%
>1978	1129	18.53 (0.30)	13.17 (3.19)	42.2%	57.8%

<sup>a</sup>For participants born in Israel, origin was determined according to father's or grandfather's country of birth. West indicates Europe–America; East indicates Asia–Africa.

Table 2. Mean Age at Menarche, at First Use of Oral Contraceptives (OC), and at First Cigarette Among Female Israeli Army Recruits, 1986–2000, by Birth Year

Birth year	Age in years at menarche Mean (SD)	Age in years at first OC use Mean (SD)	Age in years at first cigarette Mean (SD)
<1970	13.41 (1.30)	17.49 (0.81)	16.68 (1.30)
1970-1972	13.31 (1.29)	17.43 (0.85)	16.54 (1.15)
1973-1975	13.19 (1.30)	17.41 (0.83)	16.35 (1.33)
1976-1978	13.10 (1.27)	17.30 (0.95)	16.17 (1.40)
>1978	13.03 (1.28)	17.14 (1.05)	15.85 (1.36)

The opinions expressed by authors contributing to this journal do not necessarily reflect the opinions of the U.S. Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention, or the authors' affiliated institutions. Use of trade names is for identification only and does not imply endorsement by any of the groups named above.

**Table 3. Effect of Year of Birth on Age at Menarche Among Female Israeli Army Recruits, 1986–2000, According to Geographic Origin, Smoking Status, and Father’s Education**

	<b>N</b>	<b>Regression coefficient</b>	<b>95% Confidence Interval</b>	<b>P</b>
<b>Simple model</b>	11,392	–0.034	–0.042 to –0.029	<.001
<b>Origin</b>				
West	4930	–0.035	–0.045 to –0.025	<.001
East	6428	–0.035	–0.044 to –0.027	<.001
<b>Smoking</b>				
Current smokers	2463	–0.036	–0.050 to –0.022	<.001
Past smokers	253	–0.070	–0.115 to –0.026	.002
Never smoked	8587	–0.035	–0.042 to –0.027	<.001
<b>Father’s years of education</b>				
<12	3292	–0.038	–0.051 to –0.026	<.001
12	4264	–0.034	–0.045 to –0.023	<.001
>12	2995	–0.035	–0.047 to –0.023	<.001

The opinions expressed by authors contributing to this journal do not necessarily reflect the opinions of the U.S. Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention, or the authors’ affiliated institutions. Use of trade names is for identification only and does not imply endorsement by any of the groups named above.