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ORIGINAL ARTICLE

Being overweight and born in the spring are associated with an increased risk for rhinitis

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Abstract

Aim: To explore the relationship between the season of birth and the prevalence of recurrent or chronic rhinitis (rhinitis).

Methods: The medical records of consecutive 17-year-old conscripts to the Israeli army were reviewed. We compared the prevalence of rhinitis between children born during different seasons. Multivariate analysis was performed with additional variables.

Results: The prevalence of rhinitis among the 1.1 million recruits was 7.1% in males and 5.3% in females. The association between birth season and the prevalence of rhinitis was highly significant ($p < 0.001$ for both genders). Spring was the birth season with the highest prevalence of rhinitis (7.4% in males and 5.5% in females). Males born in the winter and females born in the autumn had the lowest prevalence of rhinitis (6.7%, and 5.2% respectively). There was an increased odds ratio for rhinitis among those with a body mass index above 25, higher cognitive score and maternal birth country out of Israel or Africa.

Conclusions: There was an increased risk of rhinitis among young Israeli adults who were born in the spring, were overweight and had a higher cognitive-score. Family planning to avoid a spring birth and preventing overweight may reduce the risk of chronic rhinitis.

KEYWORDS
birth country, birth season, cognition, overweight, rhinitis

1 | INTRODUCTION

The causes of atopic diseases are multifactorial and not fully understood. However, it is clear that not only genetic factors but also environmental factors such as aeroallergens and pollution are involved. Identifying these environmental factors could be an important step towards further understanding the mechanisms responsible for the development of allergies and might also provide guidance for intervention. A potential factor that influences the risk for allergies is the season of birth. In the current study, we focused on rhinitis. The link between birth season and allergic rhinitis has been previously investigated.[1–13] Those studies drew conflicting conclusions

Abbreviation: BMI, body mass index

regarding both the existence of a link between birth season and allergic rhinitis and if there is a link, which season is related to a higher incidence of rhinitis.

The most common allergenic pollens in Israel come from trees including olive and cyprus as well as from grasses, and weeds[14] and they mostly bloom in the spring. The olive tree blooms between March and June and peaks in April and May, the cyprus blooms between February and June and peaks in March. Different weeds and grasses bloom throughout the year; however, none of them peak in December or January.

The purpose of this study was to explore the relationship between the season of birth and the prevalence of recurrent or chronic rhinitis (rhinitis) in a very large database of 17-year-old Israelis. We were provided access to the database of the medical corps of the Israeli Defense Force (IDF). The database comprises anonymous data from more than 1,000,000 participants. In Israel, recruitment to the army is compulsory for all 17-year-old males who are Jewish, Christian or Druze. All males undergo medical screening prior to any possible exemption. Only females of Jewish descent are obliged to join the army and all of those who do not request a discharge on religious grounds undergo medical screening. Hence, the database is an active screening of all those who are part of the compulsory conscription.

2 | METHODS

We reviewed the medical records of all consecutive 17-year-old male and female potential conscripts to the armed forces of Israel born between 1978 and 1999. Data regarding the diagnosis of rhinitis and data regarding birth season, year of birth, body mass index (BMI), maternal birth country and cognitive score were retrieved. Conscripts who were born abroad were excluded because the influence of birth season on allergies might be different in different countries.

Frequent or chronic rhinitis was diagnosed if the questionnaire completed by the primary care physician indicated frequent visits due to rhinitis. The questionnaire did not define rhinitis, it did not define the number of visits regarded as frequent and it did not contain details regarding allergic sensitization. Birth seasons were defined according to the local climate as follows: winter (December to February), spring (March to May), summer (June to August) and autumn (September to November). Every conscript had a battery of cognitive tests as part of routine evaluation. These tests yield a cognitive score that is equivalent to a normally distributed intelligence quotient.[15]

The database we used was created and owned by the medical corps. We were able to perform statistical analysis but we were not given access to any individualised data. The use of the data was controlled by the research unit of the medical corps.

The research protocol was reviewed in its entirety and approved by the ethics committee of the IDF medical corps.

Key Notes

- We explored the relationship between birth season and rhinitis.
- We found a higher incidence of rhinitis among young Israeli adults who were born in the spring, who were overweight, had a higher cognitive score and whose mothers were born outside of Israel or Africa.
- Family planning to avoid a spring birth and preventing overweight may reduce the risk of chronic rhinitis.

2.1 | Statistical analysis

The prevalence of rhinitis was compared between conscripts born in each month and conscripts born in each season using the chi-squared test. Since the prevalence of rhinitis was related to birth season in the univariate analysis, a multivariate analysis was performed defining rhinitis as the dependent variable, and birth season, BMI, maternal country of birth, year of birth and cognitive score as independent variables. Odds ratios (OR) and 95% confidence intervals (95% CI) were also calculated.

3 | RESULTS

We reviewed data from 626,460 adolescent males and 454,104 adolescent females, of whom, 44,395 (7.1%) males and 23,995 (5.3%) females had rhinitis. The patients' characteristics are described in Table 1.

The prevalence of rhinitis according to month of birth is presented in Figure 1. In males, January was the birth month with the lowest prevalence of rhinitis (6.5%), and April, May and June were the birth months with the highest prevalence (7.5%–7.6%, $p < 0.001$). In females, November was the birth month with the lowest prevalence of rhinitis (4.9%), and April, May, June and July were the birth months with the highest prevalence (5.5%, $p < 0.001$). When this was split into seasons, the prevalence of rhinitis was highest in conscripts born in the spring (7.4% of males and 5.5% of females) and lowest in males born in the winter (6.7%, $p < 0.001$) and females born in the autumn (5.0%, $p < 0.001$), see Table 2.

In multivariate analysis, where the dependent variable was rhinitis and the independent variables were season of birth, year of birth, BMI, maternal birth place and cognitive score; the effect of the birth season on the prevalence of rhinitis remained unchanged (Table 3).

Compared to normal BMI between 19 and25, BMI above 25 was associated with higher odds for rhinitis. Odds ratio was 1.089 (1.060–1.118) in males ($p < 0.001$) and 1.062 (1.01–1.11) in females ($p < 0.001$). A BMI below 19 was associated with decreased odds for rhinitis in females 0.961 (0.928–0.996) $p = 0.036$, but not in males

0.993 (0.984–1.002) (Table 4). Maternal birth place outside of Israel or Ethiopia, and also in the rest of Africa in females, was associated with a significantly increased odds ratio for rhinitis. The increased odds for rhinitis ranged between 27% and 93% depending on the exact birth area (Table 4). Higher cognitive score was also associated with increased odds for rhinitis ($p < 0.001$). No association was found between year of birth and prevalence of rhinitis.

TABLE 1 Participants' characteristics

	Males	Females
Total number (*n*)	626,460	454,104
Age (mean ± SD)	17.3 ± 0.4 years	17.1 ± 0.4 years
Jewish origin	597,642 (95.4%)	449,563 (99%)
Maternal country of birth		
Israel	124,497 (19.9%)	75,058 (16.5%)
Asian part of former USSR	9677 (1.5%)	6263 (1.4%)
European part of former USSR	34,888 (5.6%)	29,529 (6.5%)
Rest of Asia	120,720 (19.3%)	92,613 (20.4%)
Rest of Europe and the Americas	116,520 (18.6%)	92,412 (20.4%)
Ethiopia	7649 (1.2%)	6131 (1.4%)
Rest of Africa	136,052 (21.7%)	105,150 (23.2%)
Other	593 (0.1%)	353 (0.1%)
Missing	75,864 (12.1%)	46,595 (10.3)
Rhinitis (*n*, %)	44,395 (7.1%)	23,995 (5.3%)

Abbreviation: USSR, Union of Soviet Socialist Republics.

4 | DISCUSSION

In this study, we examined the relationship between the season of birth and the prevalence of rhinitis in a very large cohort of 17-year-old subjects in Israel. Previous studies reported conflicting results and some did not find any association.[1–3] In those studies that documented an association, the birth season with the highest risk for rhinitis ranged from February to July,[6] May,[7] May to August,[8] grass pollen season,[9] August and October,[10] autumn,[11] less in the spring[12] and November to May.[13]

The present study contained more participants than the sum of the participants in the cited studies all together. We found that 17-year-olds' born in the spring, the principal pollen allergy season in Israel, were at highest risk for rhinitis. The increased odds for rhinitis in the spring was 12% in males compared to the winter which is the season with the lowest prevalence of rhinitis in males. The increased odds for rhinitis in the spring was 11% in females compared to the autumn which is the season with the lowest prevalence of rhinitis in females. The difference between birth seasons is not high and may

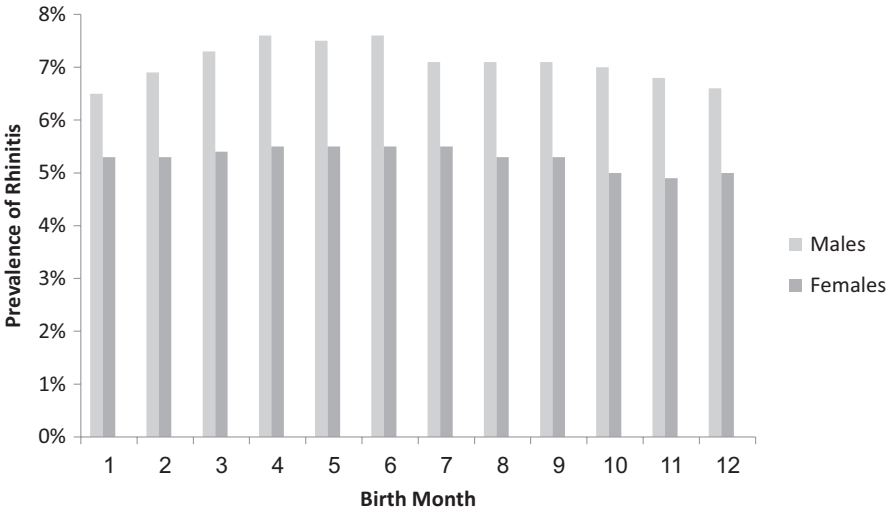

FIGURE 1 Birth months and prevalence of rhinitis in males (light grey) and females (deep grey)

TABLE 2 The total and percentage of those with rhinitis born in each season

	Birth season *n* (% of all those born in the season)				
	Winter (December–February)	Spring (March–May)	Summer (June–August)	Autumn (September–November)	*p*-value
Males	10,112 (6.7%)$_a$	11,211(7.4%)$_b$	11,693 (7.3%)$_b$	11,376 (7.0%)$_a$	<0.001
Females	5701 (5.2%)	6100 (5.5%)$_c$	6314 (5.4%)$_c$	5880 (5.0%)	<0.001

Note: The *p*-value refers to the association between birth seasons and prevalence of rhinitis. Each subscript letter ($_{a, b, c}$) denotes seasons which do not differ significantly from each other at the 0.05 level. There was no statistical significance to the difference between spring and summer in both males and females.

TABLE 3 Odds ratio for rhinitis in individuals born in spring summer and fall compared to winter

	Males		Females	
	OR for rhinitis	*p*-value	OR for rhinitis	*p*-value
Winter	1		1	
Spring	1.122 (1.090–1.155)	<0.001	1.054 (1.005–1.085)	0.008
Summer	1.088 (1.057–1.120)	<0.001	1.045 (1.014–1.095)	0.026
Autumn	1.043 (1.013–1.074)	0.004	0.952 (0.915–0.990)	0.013

Note: Results of a multivariate analysis where birth season, BMI, maternal country of birth, year of birth and cognitive score were the covariates.

TABLE 4 The influence of BMI and maternal country of birth on the odds ratio for rhinitis – results of a multivariate analysis

	Males		Females	
	OR	*p*-value	OR	*p*-value
BMI				
<19	0.993 (0.984–1.002)	ns	0.961 (0.996–0.928)	0.036
19–25	1		1	
>25	1.089 (1.118–1.060)	<0.001	1.062 (1.01–1.11)	<0.001
Maternal country of birth				
Israel	1		1	
Asian part of former USSR	1.603 (1.488–1.726)	<0.001	1.445 (1.301–1.605)	<0.001
European part of former USSR	1.930 (1.853–2.010)	<0.001	1.849 (1.753–1.952)	<0.001
Rest of Asia	1.410 (1.36–1.59)	<0.001	1.117 (1.064–1.172)	<0.001
Rest of Europe and the Americas	1.369 (1.32–1.42)	<0.001	1.160 (1.106–1.216)	<0.001
Ethiopia	0.350 (0.297–0.412)	<0.001	0.518 (0.437–0.613)	<0.001
Rest of Africa	1.027 (0.99–1.06)	0.132	0.838 (0.798–0.881)	<0.001
Other	1.458 (1.100–1.931)	0.009	0.804 (0.470–1.374)	0.425

Note: Birth season, maternal country of birth, year of birth and cognitive score were the covariates for BMI analyses. Birth season, BMI, year of birth and cognitive score were the covariates for maternal country of birth analyses.

Abbreviation: USSR, Union of Soviet Socialist Republics.

not have clinical implications. Yet, it provides evidence of the importance of environmental factors in the aetiology of rhinitis.

The difference between our findings and previous studies and the differences among the previous studies are significant. One possible explanation is that our cohort was much larger and included an active search for rhinitis. Secondly, the previous studies came from many different countries with different local aeroallergens which peak during different seasons. According to this explanation, the birth season associated with the lowest risk for allergic rhinitis cannot be universally decided but it must be evaluated separately for each geographical area.

A third possible explanation of the difference between our findings and other reports is that our database did not include data allowing a sub classification into allergic and non-allergic causes of rhinitis. Although allergic rhinitis was the most common type of chronic rhinitis and accounted for 50–75% of cases,[16–19] we were unable to determine the proportion of our cohort with non-allergic rhinitis, and this group might have influenced the association between birth season and rhinitis. We could not find any study that assessed the influence of the season of birth on the prevalence of chronic non-allergic rhinitis.

The most likely explanation for the association between birth season and rhinitis is neonatal exposure to seasonal aero-allergens.[1] The two trees responsible for most of the pollen allergy in Israel are olive and cyprus and they bloom mainly in the spring which may explain the higher rate of rhinitis seen in conscripts born in the spring. Grasses and weeds bloom throughout the year but are at their minimum in the winter months and that might be the explanation for the lower frequency of rhinitis in conscripts born in that season. The importance of early exposure to allergens in the development of allergies is suggested by a Swedish study, which assessed the influence of early high-dose exposure to birch pollen on sensitisation and development of atopic disease in children. In 1993, extremely high levels of birch pollen were recorded in Stockholm. At the age of 5 years, those children born in 1993 were more often sensitised to birch pollen than children born in years with low-dose exposure.[20] Similarly, exposure to cow's milk in the first 3 days of life is associated with an increased risk of sensitisation to cow's milk protein at

the age of 24 months.[21] Alternatively, it is possible that this association is a reflection of intra-uterine processes and is related to the season during which the pregnancy took place and not the birth. In a meta-analysis that included 10 studies, being born in the winter was associated with a statistically significant higher odds of elevated cord blood IgE.[22] Their conclusion was that this may be a marker for environmental exposures during specific stages of pregnancy. A British study[23] provided some evidence that the development of a tendency for allergies is an intrauterine epigenetic process by showing that the methylation of allergy-related genes is related to birth season. Other possible reasons for the association between season of birth and allergies may include seasonal variation in ultraviolet light and of vitamin D levels, the timing of viral infections and seasonal variations in nutrition.[13]

The multivariate analysis included variables chosen because of their potential influence on the frequency of rhinitis as will be discussed later. It revealed an association between rhinitis and each BMI, birth country and cognitive score. Other relevant variables were not included in the database and therefore could not be added to the analysis. The increased odds for rhinitis in participants with BMI over 25 was approximately 9% in males and 6% in females and was highly statistically significant in both sexes. The decreased odds for rhinitis in participants with BMI under 19 was less pronounced (only 4% in women and 1% in men) and statistically significant only in women. Previous studies examining the relationship between rhinitis and BMI reported conflicting results. Two studies found no association between allergic rhinitis and BMI,[24,25] one study in adolescents found a link between high BMI and a tendency to allergic rhinitis but only in girls.[26] Another study[27] found that there is a link between obesity and non-allergic rhinitis, but not allergic, in adults. The same study found a negative association between central adiposity and allergic rhinitis, but not non-allergic, in children. The reason for the association between rhinitis and BMI might be related to the inflammatory processes involved in both conditions which may be synergistic. A similar association between BMI and asthma has been reported. There is a debate whether the association with asthma is causative or a reflection of increased respiratory symptoms experienced by obese patients being misinterpreted as asthma. Since rhinitis and asthma share principal pathophysiological pathways, our observation that there is a link between rhinitis and BMI increases the likelihood that the link between asthma and BMI is causative.

We also found a positive relationship between rhinitis and cognitive score. We could find only two previous studies assessing the possibility of such a link. One was an Iranian study with 180 participants[28] and the other one was from Nigeria with 128 participants.[29] In contrast to our findings, both studies found no association between rhinitis and IQ. The association that we have described may not be a true increased incidence of rhinitis but may be explained by increased diagnosis due to increased awareness of rhinitis. Another possibility is that the higher cognitive score is associated with better living conditions, with increased hygiene that promotes development of allergies according to the hygiene hypothesis.

The current study included adolescents born between 1978 and 1999. In those 21 years, there was no change in the prevalence of rhinitis. Unlike our findings, a study done on conscripts to the Finnish Defense Forces revealed an increase in the prevalence of allergic rhinitis from 0.06% to 10.70% during the period 1966–2017.[30] One possible explanation for the difference between the studies is the difference in the study periods.

The odds for chronic rhinitis was noticeably higher (27%–93%) in conscripts whose mothers were born outside of Israel and Africa. This finding is surprising in light of the fact that 95% of the study participants were of Jewish descent with similar genetic make-up to the Jews living in Israel for generations. In other words, since all Jews in Israel are descendants of immigrants, the difference between those whose parents were born in Israel and those whose parents were born outside of Israel might be the number of generations after immigration and not genetic. Possible explanations include different dietary habits among first generation immigrants or different living conditions or hygiene in their houses. It is also possible that the prevalence of rhinitis in mothers born outside of Israel and Africa was higher than in those born in Israel or Africa due to local conditions and that those mothers transmitted the tendency for rhinitis to their offspring by epigenetic mechanisms.

4.1 | Strengths and limitations

The current study had several strengths including its size, the screening of the entire 17-year-old cohort and the fact that rhinitis was reliably diagnosed by a physician. The large size of the study and the availability of additional medical information enabled us to identify the formerly under-recognised influences of BMI and maternal origin on the prevalence of rhinitis. The limitations of the study stemmed from its retrospective nature and the lack of important clinical variables. The definition of rhinitis and the definition of frequent visits due to rhinitis were assigned by the primary care physician but not standardised. In addition, the diagnosis of rhinitis, combined all types of rhinitis. It is possible that only allergic or only non-allergic rhinitis were influenced by the season of birth. Similarly, we did not have access to data regarding allergic background, eczema, smoking exposure, day care attendance, respiratory tract infections and pets at home which could have added to the understanding of factors influencing the prevalence of rhinitis in our cohort. Lastly, the prevalence of rhinitis in our study population is relatively low. We cannot rule out the possibility that only severe cases were diagnosed and our results may only reflect risk factors for those with severe rhinitis.

5 | CONCLUSIONS

The risk for recurrent and chronic rhinitis is influenced by birth season, BMI, cognitive-score and the country of birth of the mother in our cohort. Family planning to avoid a spring birth, and subsequently

ensuring that adolescents keep their BMI below 25, may reduce the risk of rhinitis.

CONFLICT OF INTEREST

None of the authors have any potential conflicts of interest to declare.

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