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Original Research

Association between obesity and asthma among Arab Israeli adolescents compared with Jewish Israeli peers

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ABSTRACT

Background: Ethnic differences in the health implications of adolescent obesity, including asthma, are understudied in Israel. We compared associations between adolescent weight categories and asthma among Arab Israeli and Jewish Israeli adolescents.

Methods: This retrospective cross-sectional study used the computerized database of Clalit Health Services (CHS). It included Arab Israeli adolescents aged 14-19 years with at least one recorded height and weight measurement between 2007 and 2022. A Jewish Israeli comparison group meeting the same eligibility criteria was selected, with a socioeconomic status distribution corresponding to that of Arab Israeli adolescents. The final sample included 313,936 Arab Israeli and 289,616 Jewish Israeli adolescents. Logistic regression assessed associations between weight categories and asthma overall and asthma with inhaled corticosteroid (ICS), inhaled bronchodilator (IBD), or systemic corticosteroid (SCS) use, separately by group.

Results: Higher weight categories were associated with higher odds of asthma, with similar patterns in both groups. Among adolescents with class 3 obesity, adjusted odds ratios (95% CI) were 1.52 (1.35-1.70) for asthma overall, 2.02 (1.23-3.10) for asthma with ICS use, 2.81 (1.49-4.78) for asthma with IBD use, and 3.81 (2.16-6.19) for asthma with SCS use. Jewish Israeli adolescents had higher ICS use, whereas Arab Israeli adolescents had higher SCS use.

Conclusions: Asthma management should address obesity through healthy diet and physical activity while considering lifestyle differences between Arab Israeli and Jewish Israeli adolescents. Greater ICS use and reduced SCS use among Arab Israeli adolescents may warrant attention.

1. Introduction

Obesity and asthma are among the most prevalent health conditions in childhood and adolescence. Recent studies reported a global age-standardized prevalence of obesity in school-aged children and adolescents of 6.9% in girls and 9.3% in boys in 2022 [1] and a prevalence of adolescent asthma of 9.1% [2]. Both have significant short and long-term negative health ramifications [3,4]. Furthermore, the two conditions frequently coexist [5,6]. Among adolescents with asthma, obesity is a risk factor for greater asthma morbidity, including poorer symptom control, more frequent and severe exacerbations, and lower quality of life [6,7]. The causal relationship may be bidirectional, some studies reporting the development of asthma in cohorts of children with obesity [8,9] and others the development of obesity in cohorts of children with asthma [10]. There is evidence for a shared genetic predisposition [11], inflammatory cytokines [5], and altered gut microbiota [12] in both conditions.

The evidence for racial and ethnic disparities in the prevalence of childhood asthma and its severity is quite solid [13,14]. Genetic, inflammatory, cultural, and socio-economic differences are possible explanations for those disparities. However, there has been much less research on differences in the association of adolescent obesity and its severity with asthma in ethnic groups [15].

Israel's population is close to 10 million, with a Jewish majority and Arab Israelis comprising approximately 21% of the total Israeli population. Arab Israelis have distinct cultural and social characteristics. Two

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recent studies have demonstrated significant differences in lifestyle behaviors between Jewish and Arab Israeli adolescents, including higher adherence to the Mediterranean diet among Arab Israeli adolescents than among Jewish Israeli adolescents, as well as higher levels of physical activity among Jewish Israeli adolescents than among Arab Israeli adolescents [16,17]. Adolescent obesity is very prevalent among Arab population [18–20], the prevalence of asthma was reported to be lower among Arabs than Jews in Israel [21,22]. Given the public health importance of excess weight and asthma in adolescents, the aggravating impact of obesity on asthma, and the dearth of studies on the association of obesity with asthma among adolescents from different ethnic groups, we focused on this issue in the present study.

The purpose of the present study was to compare the associations between adolescent weight categories and asthma among Arab Israeli and Jewish Israeli adolescents in Israel.

2. Methods

The Ethics Committee of Clalit Health Services approved the study (approval #0102-22-COM2) and exempted it from the requirement to obtain informed consent given the retrospective observational study design and the use of existing routinely collected data. This was a retrospective cross-sectional study, based on the central computerized database of Clalit Health Services (CHS), the largest HMO in Israel, that provides health services to approximately half of the Israeli population. The study population was comprised of all Arab Israeli adolescents aged 14-19 years who are CHS members and had at least one recorded measurements of height and weight at any time during the study period between January 1, 2007, to December 31, 2022. The Jewish comparison population was similarly identified from CHS members aged 14–19 years who had at least one recorded measurement of both height and weight during the study period. To obtain a Jewish comparison cohort with a socioeconomic-status distribution comparable to that of the Arab cohort, we retained Jewish Israeli adolescents from the same socioeconomic-status categories represented in the Arab Israeli cohort. The distribution of sex was almost identical between the Arab and Jewish populations. Because socioeconomic status was generally higher among Jewish than Arab Israeli adolescents, the resulting Jewish cohort was smaller than the Arab cohort. The final study population comprised 313,936 Arab Israeli and 289,616 Jewish Israeli adolescents.

2.1. Data collection

The study database consisted of data obtained from this central computerised database. It included socio-demographic data (age, sex, ethnic sector, district of residence, and three levels of socio-economic status (based on the participant's residential zip code)). Clinical data included height and weight, BMI (and BMI percentile), recorded asthma diagnosis, major chromosomal anomalies/mental retardation, recorded atopic/allergic diseases, maximal blood eosinophil proportion, and asthma-related emergency department (ED) visits and hospitalizations during the observation period. Medication data included the purchase of long and short-acting inhaled bronchodilators (IBD), inhaled corticosteroids (ICS), combined inhaled bronchodilators with inhaled corticosteroids (ICS-IBD), and systemic corticosteroids (SCS).

2.2. Definitions of variables

BMI was defined as weight in kilograms divided by height squared in meters. Adolescent weight categories were defined as percentiles determined by the U.S. Center for Disease Control and Prevention (CDC), which were validated for Israeli adolescents [23], as ***'underweight', 'normal weight', 'overweight', 'obesity'*** (BMI <5th percentile, 5th-84.9th percentile, 85th-94.9th percentile, ≥95th percentile (not including 'Class 2' and 'Class 3 obesity'), respectively) [24]. ***'Class 2 obesity'*** was defined if BMI reached ≥120% to <140% of the 95th percentile or BMI ≥35 to <40 kg/m^2 ***'Class 3 obesity'*** was categorized in case of BMI ≥140% of the 95th percentile or BMI ≥40 kg/m^2 [24].

The diagnosis of ***asthma*** in adolescents was established by the ICD-9 codes 493.0, 493.00, 493.01, 493.02, 493.1, 493.10, 493.11,493.12, 493.20, 493.21, 493.22, 493.8, 493.81, 493.82, 493.9, 493.90, 493.91, and 493.91, and age of diagnosis ≤19 years. Defining asthma by at least one of the above listed physician-recorded ICD-9 codes was shown to be accurate in previous studies [25,26]. Major chromosomal and other congenital anomalies were defined by the ICD-9 codes 758.0, 758.1, 758.2, 758.3, 758.5, 758.6, 758.7, 758.8, 758.9, 759.5, 759.6, 759.7, 759.8, and 759.9, and moderate to severe mental retardation by the ICD codes 318, and 319.

Available medications for asthma management in Israel are: (a) ICS-beclomethasone, budesonide, fluticasone propionate, (b) IBD-terbutaline, salbutamol, formoterol, salmeterol, ipratropium, tiotropium, (c) ICS-IBD-beclomethasone-formoterol, budesonide-formoterol, fluticasone propionate-formoterol, fluticasone propionate-salmeterol, fluticasone furoate-vilanterol, and (d) SCS-prednisone, prednisolone, methylprednisolone, hydrocortisone, dexamethasone, betamethasone.

The use of IBD/ICS/SCS was defined as at least three actual purchases of these medications during the study period. Use of combined IBD-ICS was considered as the use of ICS, because they have similar clinical significance.

Maintenance therapy (ICS and ICS-IBD) is the mainstay of asthma management, and the aim of treatment is to avert the need for reliever therapy [27]. The use of reliever therapy (IBD) suggests that asthma control is poor, even worse when SCS are required [27]. When asthma symptoms are well controlled on pharmacological therapy, stopping, or stepping down medication is considered to protect children and adolescents from unnecessary adverse effects [27], so some patients with asthma might not use medications for years.

Two measures of asthma-related healthcare utilization were examined: (1) any high healthcare utilization, defined as at least one asthma-related emergency department (ED) visit or hospitalization, and (2) recurrent hospitalization, defined as at least two asthma-related hospitalizations during the observation period.

Asthma with elevated eosinophil count was defined as asthma with a maximal recorded blood eosinophil proportion >6% during the observation period.

The following outcomes served as dependent variables: **asthma** in general, **asthma with ICS use**, **asthma with IBD use**, **asthma with SCS use**, **asthma with high healthcare utilization, asthma with recurrent hospitalizations, asthma with concomitant allergic/atopic disease**, and **asthma with elevated eosinophil count**. This enabled us to examine the robustness of the findings and to characterise unique associations in each group.

We created five consecutive 4-year birth cohorts, to account for the possible effect of birth cohort on obesity, from 1988 to 1991 to 2004-2008, with the latter category encompassing five years for technical reasons.

2.3. Statistical analyses

The data were cleaned and outlying BMI measurements were deleted. The sample was finalized after exclusion of patients with major chromosomal abnormalities and mental retardation. As we aimed to examine the association of "having obesity at any point during adolescence" with comorbidities, we chose the maximal BMI measurement during the study period for each participant for further analyses. We used descriptive statistics to characterise baseline features of the study population. To assess the association of weight categories with the outcome variables (asthma in general, and asthma with ICS/IBD/SCS use), we built logistic regression models with the categorical variable of weight category as the main independent variable, and the 'normal weight' category serving as a reference. As additional sensitivity

analyses, healthcare utilization was examined as an indicator of severe asthma, defined by asthma-related ED visits or hospitalizations, and asthma phenotypes were examined according to concomitant allergic/atopic disease and blood eosinophil count. The latter analysis was restricted to adolescents with at least one available blood eosinophil measurement during the observation period; adolescents without an available measurement were not considered to have a normal eosinophil count and were therefore excluded from this analysis. Models were adjusted for sex, district of residence, socioeconomic status, and birth cohort. They were applied separately to Arab and Jewish Israeli adolescents and the effects were compared between them. Statistical analyses were conducted using the R software (version 4.3.2).

3. Results

The final sample consisted of 313,936 Arab and 289,616 Jewish Israeli adolescents. The study population selection process is described in the Methods section; a detailed description of the underlying cohort has also been reported previously [28,29]. Table 1 presents the baseline characteristics of the Arab Israeli adolescents included in the study. The Jewish Israeli comparison group had a similar socioeconomic-status and sex distribution. Ninety-seven thousand nine hundred eighty-two adolescents (31.2%) belonged to the overweight and obesity categories, of them 55,343 adolescents (17.6%) had BMI above percentile 95, i.e., belonged to one of the obesity categories (Table 1). Males constituted 49.4% of the participants. Among all weight categories more than 63% of the adolescents were from the low socio-economic class. Among adolescents in the 'underweight' category, a higher proportion resided in the peripheral Northern and Southern districts, whereas a higher proportion of adolescents in the 'obesity class 3' category resided in the central districts, i.e., Central, Dan-Petach Tiqva, and Sharon-Shomron. While the percentage of those born in most birth cohorts varied among the different weight categories, the proportion born in the earliest birth cohort (1988-1991) was lower in the 'class 3 obesity' category than in the 'underweight' category (9.8% vs. 13.4%, respectively). The percentage of asthma patients was 14.7% in the 'class 3 obesity' category and 8.9% in the 'normal' weight category. Notably, the crude prevalence of asthma patients was higher in the 'underweight' than in the 'normal weight' category (10.7% and 8.9%, respectively).

3.1. Medication use among adolescents with asthma from different weight categories

Fig. 1 shows the crude prevalence of medication use among Arab and Jewish adolescents with asthma. The use of ICS and BD in different weight categories followed a U-shaped pattern in both ethnic groups with the lowest prevalence in the overweight category and higher prevalence in both the 'underweight' and 'class 3 obesity' categories. The prevalence from the 'overweight' to the 'class 3' obesity category was 3.7% and 5.1%, from 6.5% to 8.1% for ICS, from 1.8% to 3.2%, and from 3.0% to 4.7% for IBD for Arab and Jewish adolescents, respectively. SCS use varied between 0.9 and 1.9% among weight categories with a higher prevalence in the 'class 3 obesity' category reaching 4.0% and 3.0%, in Arabs and Jews respectively. Notably, the use of ICS and IBD was higher among Jewish adolescents and the use of SCS was higher among Arab adolescents with asthma in most weight categories.

3.2. Association of weight categories with asthma among Arab and Jewish adolescents

Fig. 2 demonstrates the odds ratios (ORs) and 95% confidence intervals (CIs) for asthma and its subgroups across different weight categories, adjusted for sex, socioeconomic status, district of residence, and birth cohort. Among Arab adolescents, the adjusted odds ratio (aOR) (95% CI) for asthma was 1.16 (1.12-1.20) in the 'overweight' category and 1.52 (1.35-1.70) in the 'class 3 obesity' category, compared with the 'normal' weight reference category. A sensitivity analysis of the associations of weight categories with asthma with ICS showed an aOR (95% CI) of 1.51 (1.30-1.75) in the 'obesity' category and 2.02 (1.23-3.10), in the 'class 3 obesity' category. The association of asthma with IBD and SCS use (presumably poorer controlled asthma) was reflected by aORs (95% CI) of 2.81 (1.49-4.78) and 3.81 (2.16-6.19), respectively, in the 'class 3 obesity' category, compared with 1.64 (1.33-2.02) and 1.31 (1.02-1.67), respectively, in the 'overweight' category.

Table 1
Baseline characteristics of study participants across weight categories.

Variable, N (%)	CDC BMI Category						
	Underweight (N = 9944)	Normal weight (N = 206,010)	Overweight (N = 42,638)	Obesity (N = 42,676)	Class 2 Obesity (N = 10,142)	Class 3 Obesity (N = 2526)	Total (N = 313,936)
Sex (male)	5847 (58.8)	97,384 (47.3)	21,110 (49.5)	23,116 (54.2)	6285 (62.0)	1423 (56.3)	155,165 (49.4)
Socio-economic status							
High	71 (0.7)	1380 (0.7)	244 (0.6)	218 (0.5)	38 (0.4)	11 (0.4)	1962 (0.6)
Middle	2187 (22.0)	48,931 (23.8)	10,753 (25.2)	10,709 (25.1)	2545 (25.1)	615 (24.3)	75,740 (24.1)
Low	6314 (63.5)	131,062 (63.6)	26,939 (63.2)	27,084 (63.5)	6491 (64.0)	1611 (63.8)	199,501 (63.6)
Missing	1372 (13.8)	24,637 (12.0)	4702 (11.0)	4665 (10.9)	1068 (10.5)	289 (11.4)	36,733 (11.7)
District of residence in Israel							
Central	152 (1.5)	3172 (1.5)	764 (1.8)	809 (1.9)	209 (2.1)	58 (2.3)	5164 (1.64)
Northern	2050 (20.6)	42,217 (20.5)	8238 (19.3)	8164 (19.1)	1904 (18.8)	415 (16.4)	62,988 (20.06)
Haifa	1984 (20.0)	47,906 (23.3)	10,521 (24.7)	10,283 (24.1)	2380 (23.5)	549 (21.7)	73,623 (23.45)
Sharon-Shomron	1520 (15.3)	30,335 (14.7)	6763 (15.9)	7673 (18.0)	2075 (20.5)	569 (22.5)	48,935 (15.59)
Dan-PT	220 (2.2)	5430 (2.6)	1247 (2.9)	1200 (2.8)	280 (2.8)	93 (3.7)	8470 (2.70)
Jerusalem	1163 (11.7)	40,483 (19.7)	8943 (21.0)	8537 (20.0)	1939 (19.1)	492 (19.5)	61,557 (19.61)
Southern	2855 (28.7)	36,467 (17.7)	6162 (14.5)	6010 (14.1)	1355 (13.4)	350 (13.9)	53,199 (16.95)
Birth cohort:							
1988-1991	1332 (13.4)	33,515 (16.3)	5970 (14.0)	4887 (11.5)	1046 (10.3)	247 (9.8)	46,997 (15.0)
1992-1995	2277 (22.9)	54,951 (26.7)	12,152 (28.5)	11,142 (26.1)	2440 (24.1)	596 (23.6)	83,558 (26.6)
1996-1999	2370 (23.8)	50,165 (24.4)	10,860 (25.5)	11,115 (26.0)	2629 (25.9)	728 (28.8)	77,867 (24.8)
2000-2003	3011 (30.3)	55,245 (26.8)	11,055 (25.9)	12,651 (29.6)	3314 (32.7)	830 (32.9)	86,106 (27.4)
2004-2008	954 (9.6)	12,134 (5.9)	2601 (6.1)	2881 (6.8)	713 (7.0)	125 (4.9)	19,408 (6.2)
Asthma diagnosis	1067 (10.7)	18,252 (8.9)	4374 (10.3)	5524 (12.9)	1556 (15.3)	371 (14.7)	31,144 (9.9)

Underweight-BMI <5th percentile; normal weight-BMI 5th-84.9th percentile; overweight-BMI 85th-94.9th percentile; obesity-BMI ≥95th percentile, not including class 2 and class 3 obesity; class 2 obesity-BMI ≥120% to <140% of the 95th percentile or BMI ≥35 to <40 kg/m^2; class 3 obesity-BMI ≥140% of the 95th percentile or BMI ≥40 kg/m.

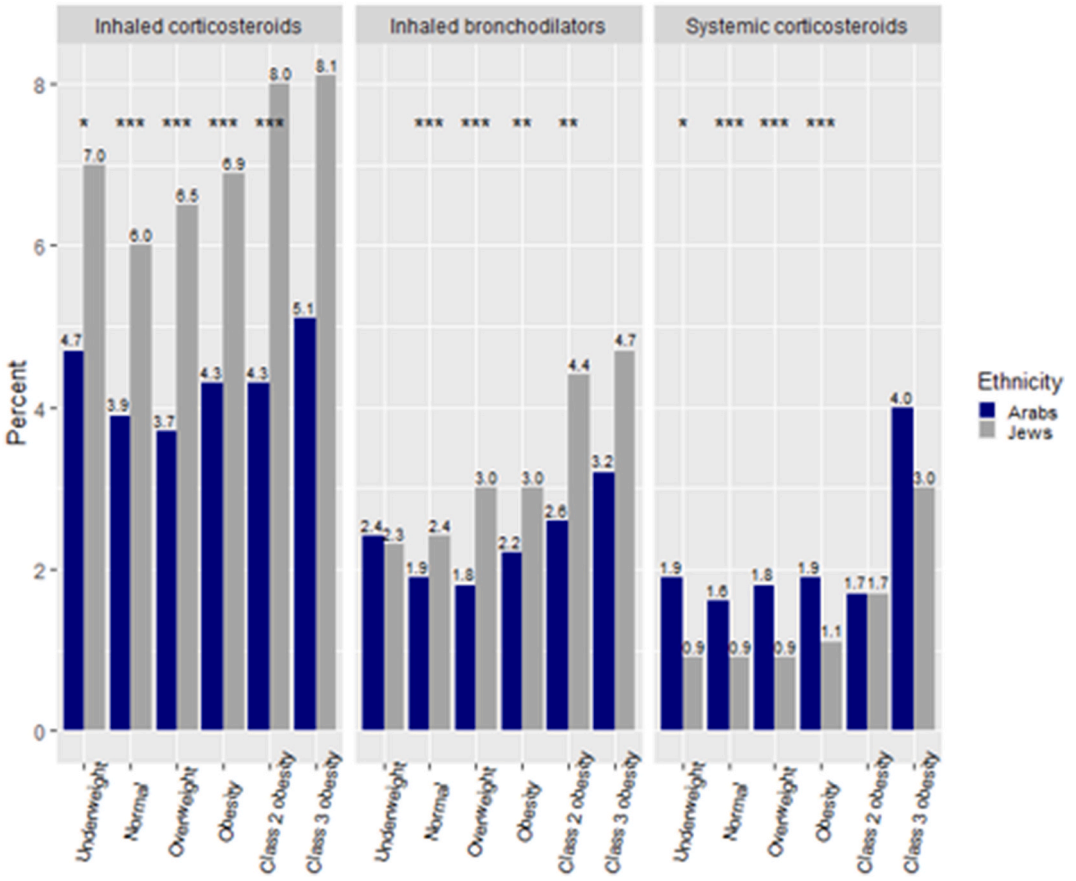


Fig. 1. Crude rates of medication use[§] among adolescents with asthma in different weight categories
[§]Defined as at least three purchases of the medication during the study period. Underweight-BMI <5th percentile; normal weight-BMI 5th-84.9th percentile; overweight-BMI 85th-94.9th percentile; obesity-BMI ≥95th percentile, not including class 2 and class 3 obesity; class 2 obesity-BMI ≥120% to <140% of the 95th percentile or BMI ≥35 to <40 kg/m^2; class 3 obesity-BMI ≥140% of the 95th percentile or BMI ≥40 kg/m^2; *difference between ethnic groups at $p < 0.05$, **difference between ethnic groups at $p < 0.01$, ***difference between ethnic groups at $p < 0.001$.

The Jewish group had similar associations of weight categories with asthma and its subgroups, with the CI overlapping those of Arab adolescents.

Full information on the aORs (95% CI) of the association of weight categories with asthma and its subgroups in Arab and Jewish adolescents is presented in Supplementary Table 1.

3.3. Sex differences in the association of weight categories with asthma

Fig. 3 presents aORs of the association of weight categories with asthma and its subtypes, stratified by sex. No noticeable sex differences were found in most of the associations of weight categories with asthma. Remarkably, among Arabs in the 'underweight' category a significant positive association with asthma in general and with asthma with IBD use was seen in males only with aORs (95% CI) of 1.11 (1.02-1.20) and 1.84 (1.15-2.80), respectively. Among Jews from the same category a significant negative association with asthma in general and with asthma with IBD use was seen in females only with aORs (95% CI) of 0.88 (0.81-0.96) and 0.53 (0.27-0.92), respectively.

Additionally, slightly higher aORs were observed for asthma with ICS/IBD/SCS use in 'class 2 obesity' and 'class 3 obesity' for females than for males.

Full information on the aORs (95% CI) of the association of weight categories with asthma and its subgroups in female and male adolescents from both ethnic groups is shown in Supplementary Table 2.

3.4. Additional sensitivity analyses

Crude asthma-related healthcare utilization by weight category and ethnicity is presented in Supplementary Table 3, with utilization rates generally higher across higher weight categories. Multivariable analyses of severe asthma with healthcare utilization showed findings similar to the main analyses, with higher odds across higher weight categories in both ethnic groups (Supplementary Table 4). Analyses of asthma phenotypes showed that the associations between weight categories and asthma with concomitant allergic/atopic disease were generally weaker than those observed for asthma overall, although positive associations persisted across higher weight categories in both ethnic groups (Supplementary Table 5). For asthma with elevated eosinophil counts, no significant positive associations were observed with 'overweight' or obesity among Jewish adolescents, whereas among Arab adolescents, significant associations were observed from the 'overweight' category onward and were stronger across higher obesity categories (Supplementary Table 5).

4. Discussion

This study is the first to examine the association of different weight categories with asthma and its subgroups among Arab Israeli adolescents and a Jewish Israeli comparison group. The association between higher weight categories and asthma was evident already in the 'overweight' category. Previous studies and a recent meta-analysis that assessed the association of obesity with asthma didn't differentiate

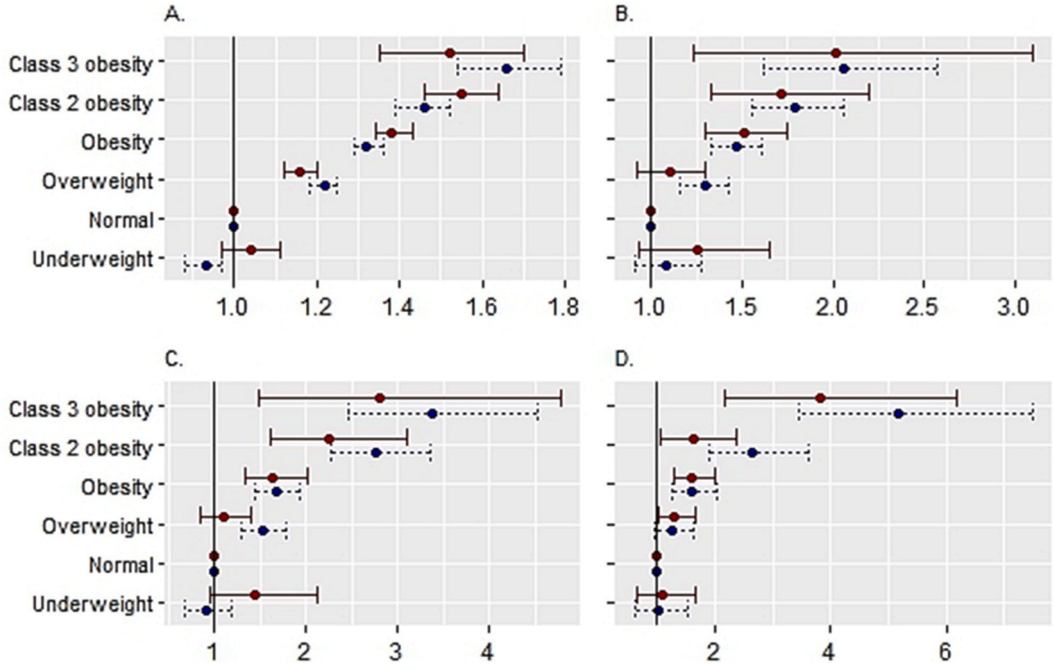


Fig. 2. Association of weight categories with asthma and its subtypes

Solid lines - adjusted odds ratios (95% Confidence Intervals) for Arab adolescents; dotted lines - adjusted odds ratios (95% Confidence Intervals) for the Jewish group. Adjusted for sex, socio-economic-status, district of residency, and birth cohort.

A - asthma; B - asthma with inhaled corticosteroids use; C - asthma with inhaled bronchodilators use; D - asthma with oral cosrticosteroids use. Use defined as at least three purchases of the medication during the study period.

Underweight-BMI <5th percentile; normal weight-BMI 5th-84.9th percentile; overweight-BMI 85th-94.9th percentile; obesity-BMI ≥95th percentile, not including class 2 and class 3 obesity; class 2 obesity-BMI ≥120% to <140% of the 95th percentile or BMI ≥35 to <40 kg/m^2; class 3 obesity-BMI ≥140% of the 95th percentile or BMI ≥40 kg/m^2.

between different excess weight categories, but reported an association with asthma in individuals with obesity compared to normal weight [30]. The strength of association they reported was similar to our result of 1.39. A large study from the US also demonstrated an incrementally higher risk across weight categories, up to 1.37 for 'severe obesity' [31]. A meta-analysis that examined the association of overweight and obesity with asthma separately, found aOR of 1.19 to 2.02, respectively [9].

We also demonstrated higher aORs for different weight categories in the analyses of asthma with IBD, ICS, and SCS use. The use of treatment, especially IBD and SCS usually indicates poorer control and more severe asthma, and while no other study used the same exact method of assessment or correlation of weight categories with asthma severity, several other studies demonstrated that obesity was associated with more IBD use, ICS use and even ICS failure with a need for SCS [31–35]. Notably, Jewish Israeli adolescents in most weight categories used inhaled medications more, while Arab Israeli adolescents used less preferred oral corticosteroids treatment more. Sensitivity analyses based on asthma-related healthcare utilization provided an additional indicator of clinically significant asthma morbidity. Higher weight categories were associated with greater odds of at least one asthma-related ED visit or hospitalization and of recurrent hospitalizations in both ethnic groups, suggesting that the association between higher weight and asthma extends beyond medication use. However, these measures should be interpreted as indicators of clinically significant morbidity rather than direct measures of asthma severity, as healthcare utilization may also reflect healthcare-seeking behavior and other factors.

Additional phenotype analyses further contextualized the association between excess weight and asthma. Associations with asthma accompanied by allergic/atopic disease were generally weaker than those observed for asthma overall, although positive associations persisted across higher weight categories, consistent with the heterogeneous nature of obesity-related asthma, which may include both atopic and non-atopic phenotypes [36]. The ethnic pattern observed in the eosinophil analysis, with associations observed beginning in the overweight category among Arab Israeli adolescents but not among Jewish adolescents, may indicate heterogeneity in the inflammatory phenotype of obesity-related asthma. These finding should be interpreted cautiously because eosinophil measurements were not routinely available, and blood eosinophils alone do not fully characterise asthma endotype; FeNO, IgE, allergen sensitization, spirometry, and detailed measures of asthma control were not systematically available. Taken together, the medication-based, healthcare-utilization, and phenotype analyses provide complementary evidence regarding asthma morbidity and phenotype, but do not permit direct characterization of asthma severity or endotype. No conspicuous sex differences were observed in the association of most weight categories with asthma in general, but the aORs for asthma with IBD, ICS, and SCS use appeared to be higher for females than for males in 'class 2 obesity' and 'class 3 obesity'. Interestingly, a meta-analysis [9] that related to sex differences in association of obesity with asthma found a much stronger association for males than for females (2.47 vs. 1.25), while a recent study from Sweden [37] demonstrated the association of female sex with more severe asthma. As for the positive association of the 'underweight' category with asthma and with asthma with IBD use only among Arab males and the positive association of this category only among Jewish females, we found several additional studies that demonstrated an association of low weight with asthma, with some showing this association for females and males, while others found it for males only [37–39].

One of the main goals of our study was to highlight unique ethnic features of the association of weight categories with asthma for Arab adolescents in Israel, comparing these associations with those of the Jewish comparison group. The aORs of different weight categories with asthma, and its subtypes were very similar in the two ethnic groups. This finding is in contrast with previous studies that demonstrated, for

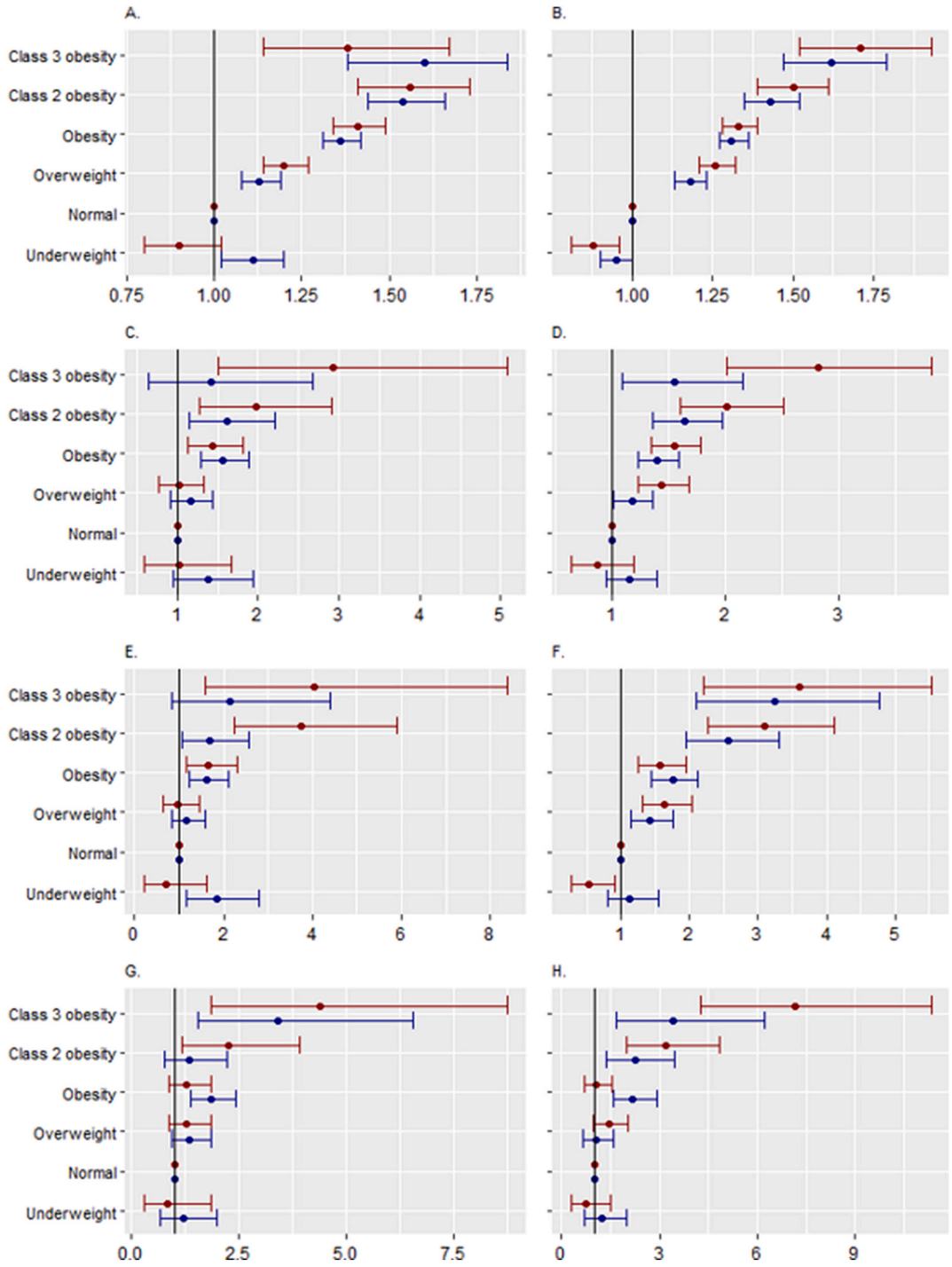


Fig. 3. Gender differences in the associations of weight categories with asthma and its subtypes in Arab and Jewish adolescents

Red lines-adjusted odds ratios (95% Confidence Intervals) for females; blue lines-adjusted odds ratios (95% Confidence Intervals) for males. Adjusted for socio-economic-status, district of residency, and birth cohort.

A,B – asthma in Arabs and Jews respectively; C,D - asthma with inhaled corticosteroids use in Arabs and Jews respectively; E,F - asthma with inhaled bronchodilators use in Arabs and Jews respectively; G,H - asthma with oral cosrticosteroids use in Arabs and Jews respectively. Use defined as at least three purchases of the medication during the study period.

Underweight-BMI <5th percentile; normal weight-BMI 5th-84.9th percentile; overweight-BMI 85th-94.9th percentile; obesity-BMI ≥95th percentile, not including class 2 and class 3 obesity; class 2 obesity-BMI ≥120% to <140% of the 95th percentile or BMI ≥35 to <40 kg/m^2; class 3 obesity-BMI ≥140% of the 95th percentile or BMI ≥40 kg/m^2. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

example, higher aORs for the Asian/Pacific Islanders, and non-Hispanics in the USA [15,16,30], compared to the other ethnic groups, and for Filipino Americans, compared to other Asian Americans [13]. The similarity of the associations between the ethnic groups in our study could stem from their common Middle East origins with little genetic variance and the same environmental hazards [40]. Lastly, the entire population of Israel, regardless of ethnicity and socio-economic status, is covered by the same National Insurance Law that provides equal health

service coverage to the whole population [41], thus possibly narrowing gaps in health characteristics. Nevertheless, equal insurance coverage does not necessarily imply similar healthcare utilization or delivery of care. Although Arab and Jewish adolescents generally receive primary care in separate neighborhood clinics serving their respective communities, physicians receive the same healthcare-system training, and secondary and tertiary care is provided through the same healthcare system and clinics. Previous Israeli studies have demonstrated ethnic differences in healthcare utilization despite universal coverage [42,43]. Differences in cultural, socioeconomic, and health-seeking factors, may therefore contribute to differences in asthma management. Our database could not determine whether management practices or adherence to asthma-management guidelines differed between the neighborhood primary-care clinics. The greater use of systemic corticosteroids among Arab adolescents may reflect differences in asthma severity, treatment adherence, or patterns of primary-care management. Our database did not contain sufficient information to determine the underlying reasons for this difference. The more extensive use of oral corticosteroids among Arab adolescents with asthma should generate attention and guide the actions of health care leaders. Further research is warranted to clarify the factors underlying these differences and to identify opportunities for targeted improvement in asthma management.

5. Limitations and strengths

The main limitation of the present study is a possible selection bias, as it was based on the BMI measurements of adolescents from the computerised medical record. Although BMI measurement is included in the Israel National Program for Quality Indicators in Community Healthcare, the availability of BMI measurements may still have been related to healthcare utilization and other characteristics of the adolescents; therefore, selection bias due to missing BMI measurements cannot be excluded. The second limitation is that the asthma diagnosis was based on medical records, which could lead to an overestimate if the doctor erroneously diagnosed asthma due to wheezing episodes at a young age), or to an underestimate if the doctor did not record the diagnosis.

Medical surveillance could have yielded more accurate diagnoses, but this approach was impossible in a study based on a large nationwide database. However, the analysis of the outcome asthma variable, in association with the use of accepted treatments in sensitivity analyses, yielded a stronger graded association of weight categories with asthma. A cross-sectional study design does not enable causal inferences, only associations. The main strength of this study is that it was based on a nationwide, representative, large and reliable database, with a high number of observations. Another strength is that the weight and height measurements and the recording of diagnoses were done by health care professionals and not self-reported. The analysis of weight categories, instead of simply dividing into “obese” and “nonobese” categories, made it possible to demonstrate subtle differences in associations across the categories.

6. Conclusions

The results of this study demonstrate a graded association between weight categories and asthma and its subgroups among Arab and Jewish Israeli adolescents, which is especially strong for females in the ‘class 2 obesity’ and ‘class 3 obesity’ categories. Contrary to the study assumptions, no unique ethnic characteristics were found for these associations and their pattern of association in the Arab Israeli adolescents compared with their Jewish Israeli counterparts. However, ethnic differences were observed in asthma medication use patterns, with greater use of inhaled corticosteroids among Jewish Israeli adolescents and greater use of systemic corticosteroids among Arab Israeli adolescents, as well as in the sex-specific associations between weight categories and asthma. These findings suggest a need to strengthen preventive asthma management among Arab Israeli adolescents, including improved adherence to inhaled corticosteroid therapy and reduction in the use of systemic corticosteroids. This study provides further evidence for the health ramifications of obesity in adolescence and highlights the need for preventive measures for asthma in adolescents with obesity, especially females from the ‘class 2’ and ‘class 3’ obesity categories, and males from the ‘underweight’ category. Prevention should also address potentially modifiable lifestyle factors, including diet and physical activity. Given previously reported differences in these behaviors, with less healthy dietary patterns among Jewish Israeli adolescents and lower physical activity among Arab Israeli adolescents, targeted interventions addressing the specific lifestyle needs of each population may be warranted.

CRediT authorship contribution statement

Yulia Treister-Goltzman: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Idan Menashe:** Writing – review & editing, Supervision, Methodology, Data curation, Conceptualization. **Dan Nemet:** Writing – review & editing, Supervision, Project administration, Methodology, Data curation, Conceptualization.

Ethical approval

The Ethics Committee of Clalit Health Services approved the study (approval #0102-22-COM2) and exempted it from the requirement to obtain informed consent. The exemption from informed consent was since it is a large retrospective cohort study, carried no risk to the participants and all personal information was de-identified.

Previous presentations

None.

Data statement

Data available on request due to restrictions (The data that support the findings of this study are available from Clalit Health Services, Israel. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from the author(s) with the permission of Clalit Health Services, Israel).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.rmed.2026.109214.

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