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Original article

Obesity increases the prevalence and the incidence of asthma and worsens asthma severity

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SUMMARY

Background & aims: We aimed to explore the association between obesity and asthma prevalence, incidence and severity.
Methods: The study included 32,644 adults, 52.6% female, from a representative sample of the 4th Portuguese National Health Survey. The following asthma definitions were used: ever asthma (ever medical doctor asthma diagnosis), current asthma (asthma within the last 12 months), current persistent asthma (required asthma medication within the last 12 months), current severe asthma (attending an emergency department because of asthma within the last 12 months), and incident asthma (asthma diagnosis within the last 12 months). Body mass index was calculated based on self-reported weight and height and categorised according to WHO classification. Logistic regression models adjusted for confounders were performed.
Results: Prevalence of ever asthma was 5.3%, current asthma 3.5%, current persistent asthma 3.0%, current severe asthma 1.4%, and incident asthma 0.2%. Prevalence of obesity was 16%, overweight 37.6%, normal weight 44.6% and underweight 0.2%. Being overweight, obesity class I and II, and obesity class III were associated with an OR (95% CI) with ever asthma 1.22 (1.21–1.24), 1.39 (1.36–1.41), 3.24 (3.08–3.40) respectively; current asthma 1.16 (1.14–1.18), 1.86 (1.82–1.90), 4.73 (4.49–4.98) respectively; current persistent asthma 1.08 (1.06–1.10), 2.06 (2.01–2.10), 5.24 (4.96–5.53), and current severe asthma 1.36 (1.32–1.40), 1.50 (1.45–1.55) and 3.70 (3.46–3.95), respectively. Considering the incidence of asthma, obesity more than quadrupled the odds (OR = 4.46, 95% CI 4.30, 4.62).
Conclusion: Obesity is associated in a dose dependent way with an increase of prevalent and incident asthma, and it seems to increase the odds of a more persistent and severe asthma phenotype independently of socio-demographic determinants, physical activity, and dietary patterns. Our results provide rational for future lifestyle intervention studies for weight reduction in the obesity–asthma phenotype.

1. Introduction

Asthma and obesity are both complex and multifactorial chronic health conditions, wherein host and environmental factors play a determinant role, and represent a serious economic and social burden in health care systems and patient's quality of life [1,2]. Although there have been advances in the knowledge, management and treatment, asthma prevalence is rising globally and disease control remains difficult [3]. Furthermore, the lack of a precise and consensual definition of asthma hinders a reliable comparison of reported prevalence from different countries. Currently, global prevalence seems to range between 1 and 16%, with western Europe showing a decrease and low income regions, where

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prevalence was previous low, currently on the rise [2,4,5]. Meanwhile, National Health and Nutrition Examination Survey (NHANES) data has indicated that almost one in three asthma patients were obese and that the prevalence of obesity between subjects with current asthma has increased from 21.3% (NHANES I) to 32.8% (NHANES III) [6]. Recently, an EAACI meta-analysis showed that weight gain per se, almost double the odds of incident asthma [7].

The description of a putative link between the high prevalence of asthma and obesity must increase efforts to better understand the so far unclear mechanisms underlying the association between these two epidemics [1,8]. The literature describes some plausible leads such as mechanical factors, inflammatory conditions and stress triggers [9,10]. Indeed, obesity is known to be associated with chronic low-grade systemic inflammation, mediated by increased levels of the pro-inflammatory leptin and plasminogen activator inhibitor and decreased levels of the protective anti-inflammatory adiponectin [11]. Nonetheless, and providing support to the mechanical hypothesis linking obesity and asthma, we have previous reported a negative association between BMI and exhaled nitric oxide in overweight and obese asthmatics [12].

Moreover, evidence suggests that obesity increases, not only, the risk of asthma, but also, the severity of respiratory symptoms by decreasing lung function and increasing airway hyperreactivity (AHR), albeit contributing towards a more difficult-to-control asthma phenotype [2,13,14] Severe asthma is considered an heterogeneous disease in which a variety of clinical, physiological and inflammatory markers determine distinct clinical phenotypes [15]. It is also worth referring that a meta-analysis showed that being overweight or obese increases the odds of incident asthma in a dose-dependent way [16]. Therefore, it is important to consider, within the clinical management of the obesity–asthma phenotype, the effect of weight reduction in obese patients. Several studies have demonstrated that weight reduction does improve lung function, symptoms, morbidity, and overall health status [17,18], with further reports of the reduction of asthma exacerbations with better control and quality of life [7,19–21]. Nevertheless, data from the previous National Health Survey (1998–99) indicated that obesity was not related with the prevalence of asthma [22], which suggests that further research on the epidemiology of obesity and asthma and on the feasibility of weight reduction recommendations should also consider other clinical outcomes and socio-economic determinants [23], including lifestyle factors such as dietary intake and physical activity.

Therefore, this study aims to explore the association between obesity and asthma in a large representative adult population, adjusting for socio-economic and lifestyle confounders, namely physical activity and dietary patterns. The hypothesis was that obesity would be associated with asthma prevalence and incidence, according to a gradient of severity in both conditions.

2. Materials and methods

2.1. Participants and study design

Data from the 4th Portuguese National Health Survey, carried out by the National Institute of Health and National Institute of Statistics (NIS), between 2005 and 2006, was analysed. The methodology of the NHS has been previously described [24,25]. In summary, the sampling frame was made based on census data and participants were selected from households during that period, using a multi-stage random probability design (hospitals, prisons, military houses and community care institutions were excluded). A representative sample of 41,193 participants from all ages was included, according to the 7 main Portuguese territorial units (NUTS II), namely North, Centre, *Lisbon, Alentejo, and Algarve, and Madeira and Azores* archipelagos. The primary sampling unit (PSU) was the housing unit and sampling was based on the population and housing census. Two levels were defined within each NUTS II: the parish (corresponding to townships); and geographically defined units of 240 lodgings (within the parish). The PSUs were then randomly selected within each territorial unit, and subjects living in the sampling unit were surveyed. Interviews were conducted in the households by trained staff interviewers, and the questionnaire included information on social and demographic characteristics, health, and chronic diseases including asthma. The survey response rate reported by NIS, defined as the percentage of households who responded, was 76% [24,25]. For the purposes of this study, a representative sub-sample of adult participants NHS surveyed was analysed (32,644 participants).

2.2. Asthma

The following asthma definitions were used: ever asthma (ever had a medical doctor asthma diagnosis), current asthma (asthma within the last 12 months), current persistent asthma (required asthma medication within the last 12 months), current severe asthma (attending an emergency department because of asthma within the last 12 months), and incident asthma (asthma diagnosis within the last 12 months).

2.3. Body mass index

Body mass index (weight/height^2) was calculated based on self-reported weight (kilograms) and height (meters), and categorised according to the World Health Organization Classification [26], in underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), obesity class I (30.0–34.9 kg/m^2), class II (35.0–39.9 kg/m^2) and class III ($\geq$40.0 kg/m^2). For the descriptive and logistic regression analyses for asthma prevalence definitions we have merged obesity classes I (prevalence of 12.7%) and II (prevalence of 2.5%), due to the low prevalence of the later. Obesity class III was analysed separately in order to better address the increase of asthma severity according the clinical severity of obesity as well. Considering the low incidence of asthma (0.2%), the logistic regression models for incident asthma could not be performed with the four categories. Therefore, and for the purposes of this specific analysis, BMI was categorised in obesity vs. non-obesity with an agreed cut off of BMI $\geq$ 30.0 kg/m^2.

2.4. Socio-demographic, physical activity and dietary patterns

Age, gender, education, family income, smoking, physical activity level, and dietary patterns were also addressed by NHS, and analysed as potential confounders.

The physical activity level was classified as Low, Moderate and High based on questions from the short version of the International Physical Activity Questionnaire (IPAQ) [27] included in the NHS. The short 7 days self-administered version is a 7-item questionnaire that provides information about frequency and duration of 4 domains: sedentary activity, time spent walking and moderate- and vigorous-intensity PA. Physical activity within domains was estimated by weighting the reported frequency (events per week) by duration (minutes per event) and by a MET level assigned to each activity (Walking = 3.3; Moderate-intensity PA = 4.0; and Vigorous-intensity PA = 8.0). A combined total physical activity was computed as the sum of the activity domains scores (Total PA = Walking + Moderate-intensity PA + Vigorous-intensity PA) and reported as categorical score.

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