A systematic review of socioeconomic position in relation to asthma and allergic diseases

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ABSTRACT The role of socioeconomic position (SEP) in the development of asthma and allergies is unclear, with some pointing to the risks of low SEP and other research pointing in the direction of higher SEP being associated with higher prevalence rates. The aim of this systematic review is to clarify associations between SEP and the prevalence of asthma and allergies. Out of 4407 records identified, 183 were included in the analysis. Low SEP was associated with a higher prevalence of asthma in 63% of the studies. Research on allergies, however, showed a positive association between higher SEP and illness in 66% of studies. Pooled estimates for the odds ratio of disease for the highest compared with the lowest SEP confirmed these results for asthma (unadjusted OR 1.38, 95% CI 1.37–1.39), allergies in general (OR 0.67, 95% CI 0.62–0.72), atopic dermatitis (unadjusted OR 0.72, 95% CI 0.61–0.83) and allergic rhinoconjunctivitis (unadjusted OR 0.52, 95% CI 0.46–0.59). Sensitivity analyses with a subsample of high-quality studies led to the same conclusion. Evidence from this systematic review suggests that asthma is associated with lower SEP, whereas the prevalence of allergies is associated with higher SEP.

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Introduction

Decades of research on the aetiology of asthma and allergic diseases have led to the development of plausible theories on causal pathways. Nonetheless, this has made only a minor contribution to solving a complex multifactorial puzzle [1]. For many of the proposed prevention strategies related to hygiene, diet, pets, pollution and other environmental factors, the evidence is weak at best [2].

Spatial patterns in the global burden of disease

Prevalence rates of asthma and allergies have been on the rise in recent decades across the globe. The International Study of Asthma and Allergies in Childhood (ISAAC) phase III study conducted between 2001 and 2003 reported that the global prevalence rate of wheezing was 11.6% for 6–7-year-old children, and 13.7% for 13–14-year old children [3]. In Western countries, the prevalence rates of asthma, allergic diseases and associated symptoms are generally higher than in other countries. PEARCE *et al.* [4] concluded that the prevalence rate of asthma symptoms is particularly high in English-speaking countries, Western Europe and some of the more affluent Asian countries. The prevalence rate of ever having had asthma among 13–14-year old children was 16.3% in Western Europe, 22.5% in North America, and 32.4% in New Zealand and Australia, while the global average was 13.8%. Apart from these high-income countries, Latin America is characterised by high prevalence rates. Other low- and middle-income countries, such as most of the African continent, Asia and Eastern Europe, have the lowest reported prevalence rates. Ever having had asthma or having a current wheeze was reported by 5.2% of 13–14-year-olds in Africa, 4.0% in the Asia-Pacific region and 3.1% on the Indian subcontinent, compared with the global prevalence rate of 6.2% [3]. These spatial patterns suggest a causal role for the environment, perhaps mediated through exposure to allergens, hygiene, air pollution and nutrition [5]. More recently, however, time trends have started to emerge, challenging the main theories on asthma causation.

Time trends in the global burden of disease

The global burden of asthma and allergic diseases is still increasing, at a time when the differences in the prevalence rates of asthma symptoms between countries seem to be decreasing [3]. This observation can partly be attributed to the rising prevalence rates of reported asthma and allergic diseases in many low- and middle-income countries. From 1994–1995 to 2001–2003, the upward trend in the prevalence rates of asthma and allergies has been particularly strong in Latin America, Northern and Eastern Europe, Africa, North America, and the Eastern Mediterranean [3]. In some high-income countries, however, and in particular those which are English speaking, the prevalence rates of reported asthma and allergies have now been reported to fall or at least plateau [2, 3, 6–8]. At this time, study findings contradict each other and not all researchers are convinced that the plateaus or decreases in prevalence rates observed in some studies indicate a trend [9–11]. Part of the change may be related to better awareness, improved diagnostic methods and changing diagnostic criteria that have uncovered undiagnosed cases in previous decades. However, this does not explain a decrease of prevalence rates in some populations. Even a stabilisation of new cases in Western countries challenges ideas about the causal role of factors such as obesity, hygienic environments and air pollution [3].

Socioeconomic position in relation to asthma and allergies

Spatial patterns in combination with changing trends over time may provide clues to understanding the causal pathways involved in the development of asthma and allergic diseases [12]. In relation to socioeconomic position (SEP), the "hygiene hypothesis" is the theory that features most prominently in the explanation of higher prevalence rates in more affluent Western countries: maternal exposure to microorganisms during pregnancy and early childhood exposure, which are thought to be higher in less "hygienic" and poorer environments such as farms and more crowded houses, would protect against the sensitisation to allergens later in life [13]. Despite being a popular theory, the hygiene hypothesis has been widely criticized, and results for various types of exposure and in different populations contradict each other [14, 15]. In addition, the evidence on the relationship between SEP and asthma and allergies has been conflicting, with both low and high SEP being reported as a risk factor.

A nonsystematic review published in 1996 summarised results from Australia, the USA, the UK and New Zealand, and found no consistent association between SEP and childhood asthma [16]. Although many factors associated with SEP, such as environmental tobacco smoke, housing, air pollution and obesity, have been studied in relation to asthma and allergic diseases, there has been no worldwide systematic review of the evidence of associations between SEP and asthma and allergies. We aim to review the evidence on the associations between SEP and the prevalence rates of asthma and allergic diseases by presenting an up-to-date overview of the international scientific literature.

Methods

Search strategy

We conducted a systematic review on asthma and allergies and SEP in accordance with the guidelines set by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement [17]. The protocol can be accessed at PROSPERO (www.crd.york.ac.uk/PROSPERO/, registration number CRD42014008883). In step 1, the search was conducted in the PubMed database in November 2012. We chose broad string and MeSH (Medical Subject Heading) terms in our search to include any definition of asthma and allergies, and SEP (fig. 1). In addition to allergic disease in general, specific health outcomes included in the search were asthma, wheeze, allergic rhinitis, rhinoconjunctivitis, food allergy, food hypersensitivity, atopic dermatitis, anaphylaxis and urticaria. Variations for SEP used in the search were socioeconomic status, social class, poverty, social disadvantage and deprivation. In order to include all relevant evidence available on this topic, we applied no timeframe or language filter.

Article selection and retrieval process

In step 2, all titles and abstracts were screened by two members of the research team (B. Cabieses and E. Uphoff) for keywords related to asthma and/or allergies and SEP. A random sample of 20% of the studies was selected for double-checking and agreement between independent reviewers was high (>98%). In step 3, full texts of the articles were retrieved or, for those manuscripts not accessible *via* institutional subscriptions, the authors were contacted *via* e-mail. In step 4, all full-text articles were reviewed by one author (M. Valdés) and a final decision on their inclusion in or exclusion from this review was made based on the criteria in table 1.

Discussion papers and reviews provided background to our systematic review but were not included in the data extraction form as they did not provide primary data. Studies that, upon extraction of the data in step 5, were found not to fit the inclusion criteria were not included in the results of this review. The search was updated in January 2014 to include recently published articles.

Data extraction

The data extraction form was designed in Microsoft Access (Microsoft Corp., Redmond, WA, USA), assessed by one of the authors not involved in the data extraction (M. Pinart) and piloted with 10 articles, which lead to minor modifications (online supplementary material). One of the reviewers performed the data extraction and quality assessment of each study (M. Valdés). Assessment of quality was based on version 4 of the STOBE (Strengthening the Reporting of Observational Studies in Epidemiology) guideline and the 2011 version of the MMAT (Mixed Methods Appraisal Tool), and incorporated into the data extraction form [18, 19]. A score from 0 to 6 was assigned to each study based on six quality criteria: "sample is representative of the population under study", "sample size is adequate", "measures are adequately described and the rationale for their use is justified", "the method of data analysis is appropriate to answer the research question" and "analyses are adjusted for confounders or differences between groups". Studies that fulfilled zero to two criteria were labelled "poor quality", three to five was considered "average quality" and all six criteria met indicated "good quality".

Pooled estimates

Pooled estimates were based on 147 unadjusted and 153 adjusted odds ratios or similar measures of association from 86 studies, as not all studies provided the necessary information. Inverse variance weights were used to take into account sample sizes of individual studies. Studies based on hospitalisations for asthma or allergies were excluded from the pooled estimate, as were country-level analyses (online supplementary material).

(Asthma[tiab] OR respiratory sound*[tiab] OR wheez*[tiab] OR rhinitis[tiab] OR rhinoconjunctivitis[tiab] OR food allergy[tiab] OR food hypersensitivity[tiab] OR atopic dermatit*[tiab] OR eczem*[tiab] OR anaphyla*[tiab] OR urticaria[tiab] OR allerg*[tiab])

AND

((health status dispartities OR health inequality OR health inequity OR health inequalities OR health disparity OR health disparities OR Health Status Disparities[Mesh])

OR

(socioeconomic status OR social class OR poverty OR poor OR income OR disadvantaged OR deprivation OR deprived OR socioeconomic factors OR socioeconomic position OR deprivation OR deprived OR Socioeconomic Factors[Mesh]))

FIGURE 1 Search terms and equations used for this review in the PubMed database. The term "IgE sensitization" was not included in the search but was described in the results section if it emerged as relevant during analysis.

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TABLE 1 Inclusion and exclusion criteria

Inclusion criteria	
Studies using any type of epidemiological design addressing the association between the prevalence rates of asthma and/or allergies and SEP	
Exclusion criteria	
Population	
	Mixed sample of children and adults if results were not presented separately
Objectives	
	Assessed biological aetiology of asthma or allergies (genomics, proteomics, transcriptomics or metabolomics)
	Assessed severity, treatment or access to services of asthma or allergies
Type of articles	
	Experimental studies
	Genetic analysis

SEP: socioeconomic position.

Results

A total of 4407 hits were retrieved from the literature search, of which 183 were finally selected for inclusion in the analysis (fig. 2). Most studies were excluded because no analysis on SEP was performed or because the exacerbation or severity of disease rather than the development of asthma and allergies was the focus of the study. All 183 studies included in this review can be found in the summary table in the online supplementary material.

Overview of studies

Many studies were based on data from the ISAAC phase 1, 2 or 3 surveys, and others either adapted the ISAAC questionnaire for their own use or applied it without changes. The map in figure 3 shows the countries represented in these surveys. Excluded from the map are two studies using subsamples from international surveys without specifying which countries were included [20, 21]. The map shows that the Americas and Europe were well represented, while African countries were poorly represented. Ecuador and Brazil were overrepresented in Latin America, and data from the Middle East were disproportionally collected from Turkey. For some countries, the large number of studies is explained by national or regional birth cohorts, such as the Pelotas birth cohort study in Brazil, from which seven out of 17 studies drew data. In Turkey, however, all six studies were based on cross-sectional data collected from different parts of the country. A total of 32 countries not represented in the ISAAC surveys were covered by other surveys or cross-sectional studies.

The majority of included studies applied a cross-sectional design (n=124), followed by 42 prospective longitudinal studies, eight case–control studies, five retrospective longitudinal studies and four time series designs. Table 2 presents an overview of study characteristics. Studies included in this review were largely published after 2000, which partly reflects the growing interest in social determinants of health and partly the limited availability of older papers. This synthesis of results shows a preference for parental education and income as measures of SEP. The main source of information on SEP tended to be self-reported or parent-reported data, with census data and medical records also being used to extract this information. The measurement of health outcomes varied from parent-reported asthma and allergies to doctor-diagnosed medical illnesses extracted from medical records. Allergic disease indicated by tests for allergen-specific IgE generally lead to higher prevalence rates than medically diagnosed or self-reported allergies. In the study by Hoffmann *et al.* [22], for example, the parent-reported prevalence of ever having had allergies was 12.5%, while tests showed allergic sensitisation in 58.4% of cases.

Quality of studies

Detailed information about the quality of each study can be found in the online supplementary material. 24 studies were classified as poor quality, 41 were considered good quality and the remaining 118 were rated as average quality. The transparency of publications was affected by main aspects of the study design and execution not being reported. Most common was the lack of a discussion of the generalisability of study results (n=9) and a statement of funding received (n=43). Furthermore, 42 studies did not adjust for any confounders and 12 studies did not describe clearly the rationale for certain measures used. Two studies, for example, did not specify how their SEP variables were defined or measured [23, 24]. Three studies used the UK system of classification of occupations but did not make this explicit [25–27]. In addition, 18 studies were underpowered for the analyses performed, resulting in very wide confidence intervals for the risk estimates.

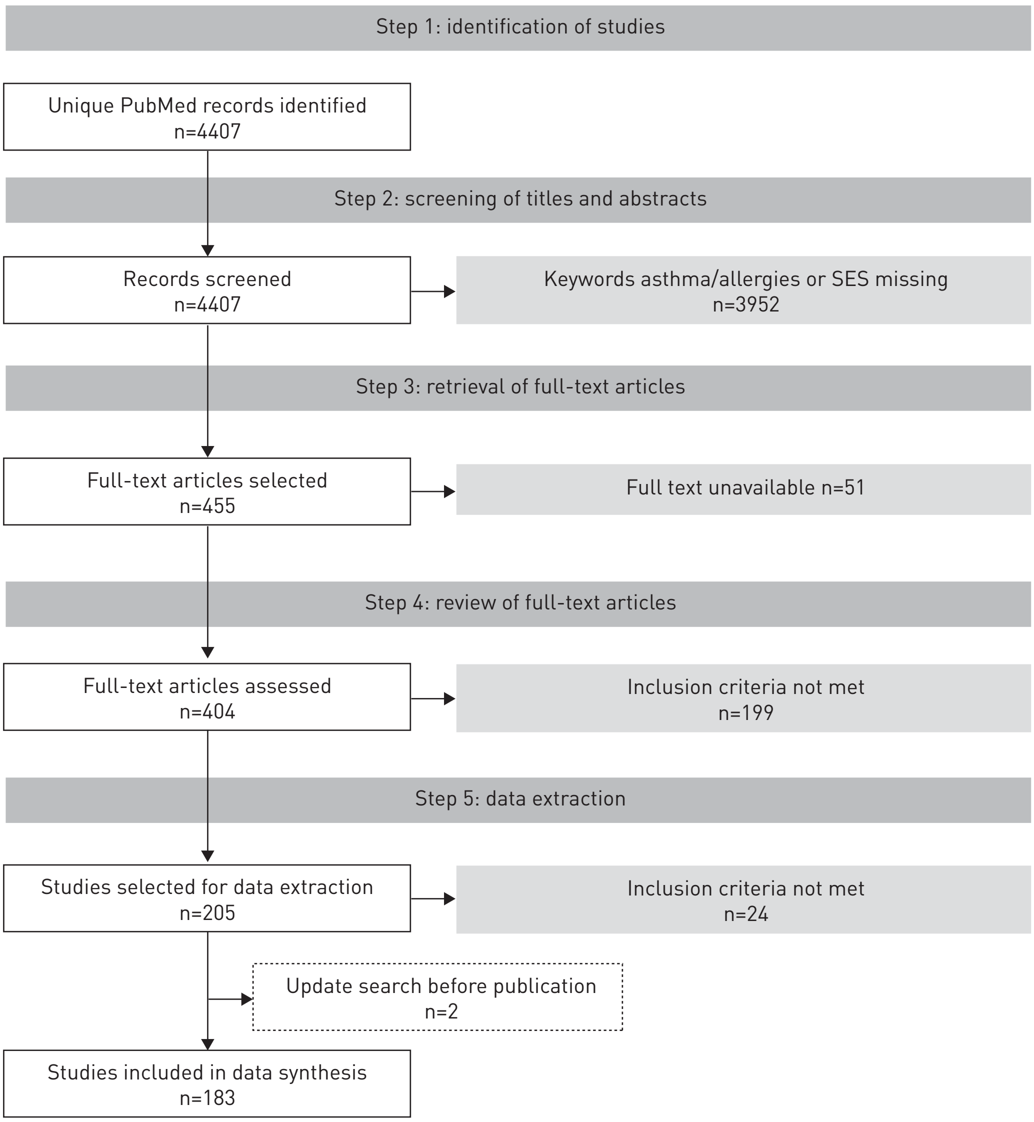

FIGURE 2 PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart. SES: socioeconomic status.

Association between asthma and SEP

A positive relationship between SEP and the prevalence rate of asthma or wheeze was found in only 9% of the studies, whereas 63% reported lower SEP to be associated with higher odds of asthma. The association between lower SEP and a higher prevalence of asthma was found in studies with children and adults, and across world regions. The pooled unadjusted odds ratio for the prevalence of asthma for people of the lowest SEP compared with the highest SEP was 1.38 (95% CI 1.37–1.39) and the odds ratio adjusted for a wide range of covariates was 1.11 (95% CI 1.09–1.14) (online supplementary material). Some studies

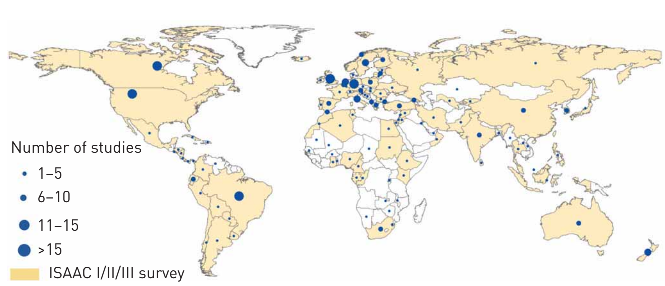

FIGURE 3 Setting of research conducted on asthma/allergies and socioeconomic position. ISAAC: International Study of Asthma and Allergies in Childhood.

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TABLE 2 Characteristics of studies included in the systematic review

Study characteristics	Studies[#] n
Total	183
Year of publication	
Before 2000	30
2000–2005	48
2006–2010	67
After 2010	38
Level of analysis	
Individual	155
Area level	14
Multilevel	14
Region	
Africa	83
Asia	111
Europe	199
South America	61
North America	46
Oceania	25
Sample size	
<200	6
200–1000	31
1001–5000	60
5001–10 000	26
10 000–100 000	30
>100 000	6
Age category	
Children (<18 years old)	119
Adults	39
Mixed	25
Health outcomes	
Asthma	129
Wheezing	52
Allergies or allergic reactions	31
Allergic rhinitis (*i.e.* hay fever)	22
Atopic dermatitis (*i.e.* eczema)	27
SEP measures[¶]	
Parental or own education level	79
Individual or household income	76
Occupational level or employment status	43
Area-level deprivation or poverty	22
Housing characteristics	19
Country-level SES	10

For a complete overview, see the online supplementary material. SEP: socioeconomic position; SES: socioeconomic status. [#]: total may exceed 183 as some studies covered multiple regions and used multiple health outcomes and SEP measures; [¶]: only most common SEP measures included in table.

found that the relationship between asthma and SEP varied by measure of SEP. In a study among US children, for example, lower prevalence rates of asthma were associated with low family income (OR 0.33, 95% CI 0.20–0.54) but not with unemployment (OR 1.35, 95% CI 0.84–2.17) [28]. A study among children in Cuba found that those exposed to an economic crisis had lower odds of asthma than unexposed children (OR 0.40, 95% CI 0.17–0.95) [29]. The association between self-reported or doctor-diagnosed asthma and SEP was more evident than the association between symptoms of wheeze and SEP (unadjusted OR 1.02, 95% CI 0.99–1.06; adjusted OR 1.33, 95% CI 1.29–1.37) (online supplementary material).

Association between allergic diseases and SEP

In contrast to asthma, of the studies that used allergies as an outcome measure, 66% found higher individual SEP to be associated with a higher prevalence rate and 12% reported that lower SEP was associated with higher rates of allergies (table 3). The pooled unadjusted odds ratio for the prevalence of

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TABLE 3 Evidence on the associations between socioeconomic position (SEP) and allergic diseases

	Prevalence rate of allergy positively associated with		
	Higher SEP	**Lower SEP**	**Inconclusive/no association**
Allergy/atopy			
General	12	1	2
Aeroallergens			
General	3		
Outdoor allergens			1
Allergic rhinitis/rhinoconjunctivitis	11	4	
Pollen	1		2
Grass	1		
Indoor allergens	1		
Cat	1		1
House dust mite			2
Mould	1		
Cockroach		1	
Food allergy			
General	4		
Tree nut	1		
Peanut	1		
Cow milk	1		
Skin allergy			
General/itch/rash	2	1	1
Atopic dermatitis	10	2	7
Other			
Eosinophilic oesophagitis			1
Vernal keratoconjunctivitis	1		
Total n (%)	51 (66)	9 (12)	17 (22)

Data are presented as n, unless otherwise stated.

allergies or atopy in general, for people of the lowest SEP compared with the highest SEP, was 0.67 (95% CI 0.62–0.72), and the odds ratio adjusted for a wide range of covariates was 0.69 (95% CI 0.60–0.79) (online supplementary material). A lower SEP was also associated with a lower prevalence rate of atopic dermatitis (unadjusted OR 0.72, 95% CI 0.61–0.83; adjusted OR 0.79, 95% CI 0.73–0.85) and allergic rhinoconjunctivitis (unadjusted OR 0.52, 95% CI 0.46–0.59; adjusted OR 0.79, 95% CI 0.78–0.80) (online supplementary material). Reported associations between higher prevalence rates of allergic diseases and lower SES were not consistent, and varied according to the measures of SEP or the health outcomes used in the analysis.

Area-level SEP in relation to asthma and allergic diseases

A total of 19 studies reported on the association between area-level measures of SEP and either individual- or area-level health outcomes. 11 of these, most of which used measures of area deprivation or average household income, found that lower area SEP was associated with hospital admissions for asthma (n=6) [30–35], admission for anaphylactic shock [36] and the prevalence of asthma/wheeze (n=4) [37–40]. Only one study of the associations between asthma and area-level income found no significant result [41], and a study among UK adults showed an association between higher area deprivation and asthma for women but not for men [42]. Two studies using data on gross national income concluded that more affluent countries had higher prevalence rates of asthma, wheeze and atopic sensitisation [43, 44]. An ecological study making use of the ISAAC study data found a weak linear association between gross national product and wheeze and eczema, although this association was most prominent in non-European countries [45]. The remaining three studies reported mixed results [46–48].

Sensitivity analysis with high-quality studies

Including only high-quality studies confirms the relationships found between lower SEP and higher prevalence rates of asthma, and reproduces the evidence of the association between higher SEP and allergic diseases. 36 studies rated as good quality included asthma or wheezing as a health outcome (online supplementary material). Of these studies, 17 suggested asthma or wheezing were associated with lower

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SEP and only two studies found the opposite association. The remaining 17 studies either did not study this particular association (n=6) or reported mixed results depending on measures of health and subgroups within the population under study (n=11).

ALIGNE *et al.* [49] studied a sample of black and white Americans, and found that the prevalence of asthma was not related to poverty or ethnicity but to living in an urban setting. Another US study concluded that higher odds of asthma were associated with a lower SEP for African-American children and a higher SEP for Mexican-American children, while results for the “other Latino” group were not significant [50].

Eight studies on the relationship between individual SEP and allergies were rated high quality. Together, these studies reported on 11 relationships between SEP and different allergies, of which nine results in seven studies pointed towards a higher prevalence for people of higher SEP [51–57]. One study found no relationship between SEP and doctor-diagnosed atopic eczema in Japanese children [58].

Discussion

In this review of studies from mainly high- and middle-income countries, we found evidence confirming an association between lower SEP and a higher prevalence rate of asthma for children and adults. Area deprivation was also consistently associated with higher prevalence rates and hospital admission rates for asthma. In contrast, the evidence for the association between SEP and allergic diseases points in the opposite direction, with higher SEP being associated with a higher prevalence of allergies. This relationship was found for allergies or atopy in general, atopic dermatitis, allergic rhinoconjunctivitis and food allergies.

Study limitations

The findings of this systematic review are likely to be affected by bias within studies as well as bias in the pooled estimates of studies. Some studies did not provide a rationale for their choice of measures, and it is likely that measures of SEP chosen for reasons of convenience and availability may not always be the most suitable measures to detect social inequalities in health. Most studies used income or education of the parents as a proxy for SEP (table 2). Although these are often used and therefore facilitate comparison between studies, education of the parents in particular does not necessarily reflect the SEP of children in the household. In studies focussing on asthma or wheezing in children, measures of parental SEP may account for only part of the effects of social disadvantage on child health. This life-course perspective on childhood asthma was rarely considered in any of the studies. Due to the suboptimal quality of many studies, we analysed the sample rated as high quality separately. This did not lead to different conclusions on the relationships between SEP and asthma and allergies.

The generalisability of our findings may be affected by the study settings in which the data were collected. The results draw heavily upon data from Europe and the Americas, and the regions of Africa and Oceania were included in only 20% of the articles (table 2). The majority of African countries did not participate in the ISAAC surveys upon which many studies relied for their data collection (fig. 3).

Despite the large number of studies reviewed, by limiting the literature search to one electronic database, we might have not included all relevant literature. Furthermore, funnel plots indicate that not all relevant studies might have been published. There was a lack of smaller studies reporting results that contradict the main findings; in other words, a higher SEP being associated with higher prevalence rates of asthma or a lower SEP being associated with lower prevalence rates of allergies (online supplementary material).

We calculated pooled measures of association to aid the interpretation of the vast amount of data collected from the studies included in this review, despite large differences between studies in measurement of SEP, and health, setting, focus and statistical analyses. Higgins' I^2-tests indicated considerable heterogeneity in studies of all groups of health outcomes [59] (online supplementary material). We stress that this systematic review is no more than a summary of previous findings and ask that results are interpreted with caution. Although we are confident that the pooled estimates give a reliable indication of the nature of the associations between SEP and allergic diseases for the studies included in this review, this information by no means quantifies the relationship between SEP and allergic diseases in the general population.

Implications for research and policy

The evidence for an association between lower SEP and a higher prevalence rate of asthma suggests that social and economic determinants of health associated with deprivation may play a role in the aetiology of asthma. Examples of such determinants from recent research include obesity, tobacco smoking, and indoor and outdoor pollution [14, 60, 61]. People with a lower SEP may be more exposed to these factors than those with a higher SEP. However, this does not explain why the prevalence of asthma is generally lower in low-income countries, where especially residents in urban areas in tropical climates may be more exposed to indoor and outdoor pollution than in higher income countries. Research on migrants has shown that the prevalence of asthma in people migrating to high-income countries rises over time, with increased length of exposure to determinants of health in the host country [62]. More research is needed to determine which environmental factors in westernised societies drive this change in susceptibility to asthma.

Lower SEP is associated with poorer health for almost every health outcome, and our results indicate that the association between higher SEP and allergies is a notable exception. For other health outcomes, the inverse social gradient can usually be explained by demographic characteristics and health behaviour (breast cancer and skin cancer). Higher prevalence rates of allergies in higher social groups have been considered consistent with the hygiene hypothesis, which has also been linked to the lack of a social gradient or inverse social gradient for other immune disorders (*e.g.* type 1 diabetes) [63, 64]. In contrast to evidence supporting the hygiene hypothesis, a Korean study found higher rates of sensitisation to most allergies in children with a higher household income, while sensitisation to cockroach allergen was more common in children of lower SEP [65]. Evidence on cockroach allergy not included in this review confirms that higher exposure to cockroach allergens in people with a lower SEP is associated with higher, rather than lower, prevalence rates of allergy [66, 67]. We cannot draw final conclusions on the hygiene hypothesis in relation to allergies, as most studies included in this review did not measure exposure to allergens in addition to the diagnosis of allergy.

Another explanation for an inverse social gradient in allergies is that people of higher SEP would be more likely to report allergy symptoms. One study found that the prevalence of self-reported allergies was significantly higher in people of higher SEP, while laboratory results on allergic sensitisation did not reach statistical significance [22]. Two studies showed a significant inverse social gradient in parent-reported as well as clinically diagnosed atopic dermatitis, with symptoms of illness being more common among children of higher SEP [68, 69].

Although we do not provide causal evidence, this review suggests it could be useful to treat asthma and different types of allergy as separate health outcomes, particularly when investigating the social determinants of health. In addition to a well-considered health outcome, using a combination of SEP measures increases the likelihood that the effects of SEP are captured accurately for children and adults, men and women, and different ethnic groups. This nuanced approach to the examination of determinants of asthma and allergies is likely to improve our understanding of causal pathways, in order to inform clinical practice and evidence-based policy on the prevention of asthma and allergies.

Conclusion

The evidence from this systematic review suggests that the association with SEP differs for asthma and allergic diseases. Asthma is associated with lower SEP, whereas allergies are more often associated with higher SEP.

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