






STATE OF THE ART

A worldwide charter for all children with asthma

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Abstract

Childhood asthma is a huge global health burden. The spectrum of disease, diagnosis, and management vary depending on where children live in the world and how their community can care for them. Global improvement in diagnosis and management has been unsatisfactory, despite ever more evidence-based guidelines. Guidelines alone are insufficient and need supplementing by government support, changes in

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policy, access to diagnosis and effective therapy for all children, with research to improve implementation. We propose a worldwide charter for all children with asthma, a roadmap to better education and training which can be adapted for local use. It includes access to effective basic asthma medications. It is not about new expensive medications and biologics as much can be achieved without these. If implemented carefully, the overall cost of care is likely to fall and the global future health and life chance of children with asthma will greatly improve. The key to success will be community involvement together with the local and national development of asthma champions. We call on governments, institutions, and health-care services to support its implementation.

KEYWORDS

asthma, charter, childhood asthma, children, global pediatric asthma

1 | INTRODUCTION

1.1 | Why we need a charter

Asthma is the commonest chronic childhood disease and encompasses a spectrum of airway diseases with similar symptoms.^{1,2} Inaccurate diagnosis remains common, especially in younger children, with failure to characterize the different “asthmas.”^{3,4} Children worldwide repeatedly suffer symptoms which severely affect their everyday lives.⁵ Children die from asthma, especially in low and middle-income countries (LMICs).^{6,7} In many countries, asthma prevalence is rising. Access to effective care and changing environments are hugely variable and may explain the higher morbidity in inner-city children, in LMICs, and in deprived populations in high-income countries.^{8,9} Despite the disease being eminently controllable, morbidity and mortality persist.^{10,11}

We previously described the barriers to better management of paediatric asthma,¹² and proposed a global Bill of Rights for children with asthma as guiding principles.¹³ Global health organizations, governments, policymakers, community leaders, local authority workers, schools, and teachers all need to play their part with the children, their families, communities, and their healthcare workers. Guidelines set standards, but with suboptimal implementation they are insufficient. Community-led projects using inexpensive medications, supported by effective policies, have greatly improved outcomes in countries such as Finland, Nigeria, Costa Rica, and Brazil.¹⁴⁻¹⁷ Important principles include (a) asthma in most children can be diagnosed by a few specific clinical questions asked by healthcare workers; (b) most children with asthma respond to inhaled corticosteroids (ICS) and a short-acting beta-agonist (SABA) using a spacer; (c) repeated, simple education can deliver better, safer care that addresses individual and community beliefs, and; (d) asthma action plans effectively reduce risk.

We aim to highlight that:

1. Children worldwide are suffering and dying from a treatable disease through misdiagnosis and failure to implement effective treatments.

2. Universal health coverage must be extended to include diagnosis and treatment of childhood asthma
3. The Children's Asthma Charter is a way to improve care globally.
4. Solutions exist for the current barriers to effective asthma care.
5. A globally adaptable educational and training program tailored to local needs is available.

2 | PREVALENCE OF ASTHMA IN CHILDREN

2.1 | The global view

In 2007 the estimated global prevalence of asthma was 11% in children aged 6 to 7 years and 14% in those aged 13 to 14 years¹⁸ but is increasing, particularly in LMICs. Asthma in children is a low-ranked global noncommunicable disease (NCD), although it causes more loss of disability-adjusted life-years, than many other conditions.¹⁹ Also, NCD risk factors including lack of immunizations, poor diet, physical inactivity, obesity, smoking, cigarettes, and pollution exposure apply equally to asthma as to diabetes and cancer. Yet asthma can be well managed at low cost if there is universal access to primary care services and the medicines recommended by the 2017

TABLE 1 The seven achievable goals to reduce the asthma burden

1. Political understanding of the burden of asthma and the impact of undertreating asthma in childhood.
2. Political commitment to finance medicines and training of healthcare workers.
3. Locality-specific guidance suitable for implementation at a primary care/local community level.
4. Sufficient numbers of trained healthcare workers with appropriate equipment, such as spirometers.
5. Access to affordable, effective medicines and spacers for all.
6. Standardized case management.
7. Effective information systems with regular audit enabling good quality care, tailored over the child's lifetime.

World Health Organization (WHO) Essential Medicines List including ICS, inhaled SABAs, and oral corticosteroids.

Most national formularies include essential asthma medicines but access remains inequitable and spacers are rarely provided.^{20,21} Reducing the burden of asthma in children requires seven achievable goals (Table 1).

2.2 | Issues specific to LMICs

Asthma is the commonest NCD in children in LMICs and is often more severe than in high-income countries which may be due to factors including wrong or missed diagnosis, inadequate access to care and health systems in which asthma is low priority. Diagnosis is especially challenging due to the high incidence of respiratory tract infections and poor access to care,²² with under-diagnosis of even severe asthma common.²³ In addition, treatment guidelines, appropriate medicines, and spacers are frequently unaffordable or inaccessible.²⁰

Risk factors including tobacco and indoor biomass smoke, outdoor air pollution, and viral infection are particularly common in LMICs²⁴⁻²⁸ and in deprived communities in high-income countries. Environmental disasters, such as wildfires, hailstorms or floods, also worsen asthma control. Smoking compounds the pernicious effects of environmental tobacco smoke exposure, family psychosocial stresses and cultural factors which affect disease severity, the caregiver and the child's perception of their asthma and its treatment.

3 | CLINICAL AND RESEARCH BARRIERS TO ASTHMA IN CHILDREN

3.1 | Unmet needs: diagnosis, risk assessment, and mitigation

Fixed or variable airflow obstruction, inflammation, and infection may all result from multiple endotypes, such that "asthma is solely a

clinical description of wheeze, chest tightness, breathlessness, +/- cough which makes no assumptions about its underlying pathology."² We need to know what sort of asthma the child has, such as eosinophilic inflammation, to define a treatment strategy. Given different environments, infective agents, and genetic/epigenetic factors, asthma in Brazil, New York, and Africa is likely to have different causations, different attack risks,²⁹ and may need different management strategies. The start of successful management is making the correct diagnosis or perhaps better determining which treatable traits are present.

Possible biomarkers need further research to assess utility and affordability in LMICs. Elevated levels of exhaled nitric oxide (FeNO) or raised blood eosinophil counts likely reflect TH2 inflammation worldwide, but, where eosinophil levels are commonly elevated by parasitic infections or other causes, their value may be less clear.

Healthcare workers caring for children suspected of having asthma should undertake a full medical history including smoking history and clinical examination. They should also consider organizing spirometry with bronchodilator reversibility in children older than 5 years, FeNO, a blood eosinophil count, allergen skin prick tests, immunoglobulin E, and cough swab/sputum culture if there is poor response to ICS. These tests are frequently omitted leading to over-diagnosis.^{30,31} In LMICs, under-diagnosis is more likely.³²

ICS should be prescribed to children with eosinophilic airway inflammation. In the INFANT study of children aged 12 to 59 months,³³ a blood eosinophil count more than 300/ μ L and aeroallergen sensitization predicted response to regular ICS (Figure 1). Because the analysis was post hoc, the results need confirmation, including in populations with eosinophil levels elevated for other reasons. This study is proof of the concept that ICS are more likely to be effective with eosinophilic airway inflammation. Without eosinophilic inflammation, alternative treatment strategies need consideration. Clearly better biomarkers for both high and low type 2 inflammation are needed.³⁴

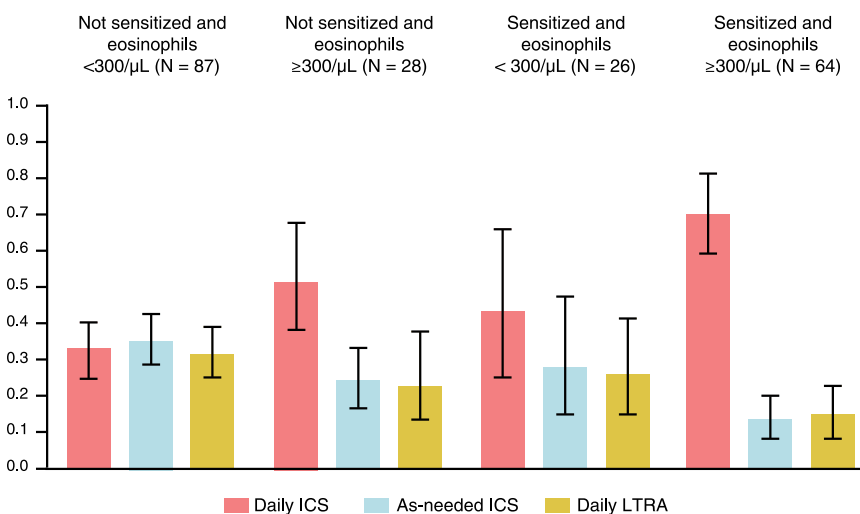
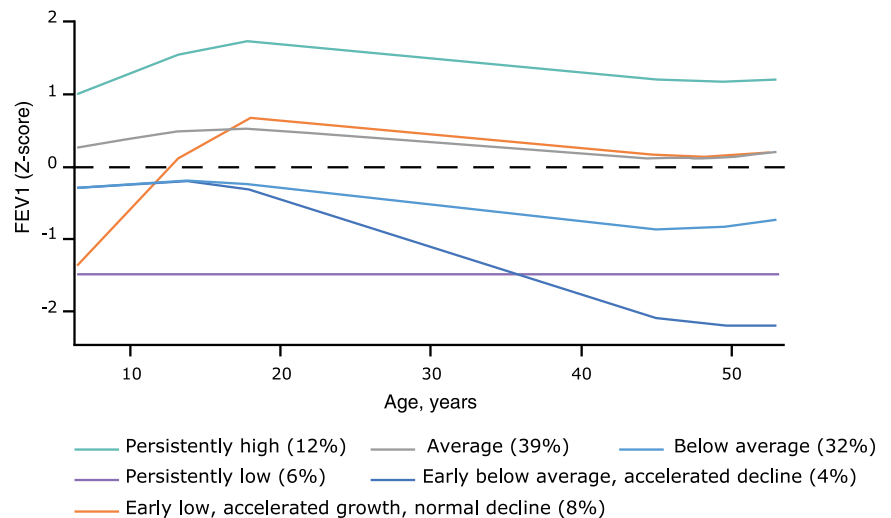


FIGURE 1 The probability of best response based on combinations of sensitization and peripheral blood eosinophil count. *P* values correspond to the test of interaction between the predictor and treatment and indicate whether the pattern of treatment response differs according to subgroup. Sample sizes correspond to participants with evaluable data (N = 230). Reproduced with permission from Fitzpatrick et al³³

FIGURE 2 Trajectories of lung function (forced expiratory volume in 1 second z-score) from 7 to 53 years of age. The six trajectories represent the latest growth patterns of lung function. The group prevalences do not add up to 100% because of rounding. Reproduced with permission from Bui et al⁴⁰



Objective biomarkers can also monitor risk. Day-to-day asthma control may be good, but the child remains at risk from an asthma attack and/or side effects of medical treatment, and impaired lung growth or fixed airway obstruction later in life. An asthma attack is the strongest predictor of risk for a future attack, but, all too often, is treated as an isolated event.^{35,36} Risk is also increased in uncontrolled type 2 inflammation.^{37,38} Measuring FeNO levels and titrating ICS dose may reduce future attacks, but successful asthma care really centers on careful history taking, good rapport with the family, ensuring treatment adherence, education, asthma management plans, and regular follow-up.

Longitudinal lung function measurements monitor lung growth. Acute asthma attacks may be associated with reduced airway growth³⁹ and a persisting low lung function trajectory (Figure 2) which is attenuated by the use of regular, low dose ICS.

Poor lung growth risks adulthood fixed airway obstruction.^{40,41} Unfortunately, currently we have no specific strategies to correct an adverse trajectory. Preventing LRTIs and exposure to indoor and outdoor pollution (antenatally and postnatally) may improve lung growth.^{42,43} In California, improvements in air quality resulted in better lung growth.⁴³ Trajectories may also improve in those with later

onset puberty.⁴⁴ The mechanism is unknown, but when discovered might reveal ways to normalize a low lung function trajectory.⁴⁵

4 | A CHARTER FOR ALL CHILDREN WITH ASTHMA

Patient advocacy and community organizations are critical in improving asthma care and holding health services to account.⁴⁶ We call on all governments and communities to support the Rights of Children with asthma by actions using a charter modified for global use in children (Table 2), which has been developed from principles published for the care of adults with severe asthma.⁴⁶ We recommend the development and recruitment of national champions together with additional professional support to improve global asthma care (Table 3).

TABLE 3 An asthma champion plan to universally improve care in children

TABLE 2 The rights of children with asthma: a charter modified for global use in children, based on principles for the care of adults with severe asthma¹⁸

- I deserve a timely and accurate diagnosis of asthma within the primary care/community setting.
- I deserve the right to medicines recommended for asthma as contained in the Essential Medicines List of the World Health Organization.
- I deserve the right to know what type of asthma I have, so I obtain the right treatment.
- I deserve referral to a specialist if my asthma cannot be controlled in the primary care/community setting.
- I deserve long-term follow-up to ensure my health and growth is monitored and evaluated.

- Each Government appoints a high-level asthma clinical director, and then a small number of senior [respiratory] paediatricians, respiratory nurses and primary care specialists who will support the national champion, and identify key professionals across the country who can provide grass roots support.
- The national champion ensures binding Government commitment to provide affordable, basic asthma medications and spacers.
- The clinical director identifies a network of named regional and local champions who take personal responsibility for the children with asthma in their region.
- The local champions, helped by the respiratory grass roots professionals, devise local guidance and protocols, modifying e.g., Global Initiative for Asthma (GINA) for local needs, and identify children with asthma to ensure their needs are being met.
- The local communities (including children themselves) are taught to “asthma-seeK”—the child who cannot run fast may have asthma, rather than just being unfit.
- The Minister of Health commits to receiving and reviewing asthma outcomes and supporting a funded long-term quality improvement program.

5 | SETTING STANDARDS AND IMPROVING GUIDELINES FOR PRIMARY CARE

5.1 | Where we need to go

Most paediatric asthma management takes place within primary care/the community where the understanding of the wider context and risk factors for local families is implicit. We need a practical, implementable package that has been codeveloped and tested in a primary care context and found to be feasible, effective, and affordable. The WHO guidelines on the management of pneumonia are an example of an effective primary care guideline, which has substantially reduced childhood mortality. Guidelines for a chronic disease like asthma are more complex, and it is possible that more equipment will be needed, such as exhaled FeNO measures, to improve the care of asthma.⁴⁷

Simple transfer of information fails to achieve good asthma management in adults,⁴⁸ and the same is probably true in children. Asthma care requires accurate and practical educational tools which can be used by the child, family, caregivers, healthcare workers, school teachers, and community health workers. The information needs to be adapted to local needs, culturally sensitive, freely available in many languages, and in narrative formats with simple illustrations to overcome poor literacy.

For asthma management, community engagement is essential.^{12,49} Guidelines need to focus on implementation, prioritization of health policy and training of healthcare staff to ensure patients understand their asthma and use what is prescribed. If local guidelines are to work, their development should include users in the wider community.

Changing perceptions of “what asthma really is,” especially in young children, have made the diagnosis, management, and labeling of wheezing disorders controversial, resulting in inconsistent guidelines.^{50,51} Management plans need to be clear, consistent, simple, and well-communicated to be useful. The healthcare workers and families need to approach asthma in children as a life-course respiratory disease. Healthcare providers should refer to secondary care if treatment is not working.

It is easy to agree to a set of standards from the evidence, as typified by the National Institute for Health and Care Excellence Asthma Quality Standard.⁵² What is more important to improve outcomes, however, is the process by which they are agreed, to ensure ownership from all stakeholders, and the incentive system to encourage implementation. The London Children and Young People Asthma Standards is a good example of the codevelopment process that involved local government, health organizations, professional societies, and civil society responsible for the health of children in London, a city of 8.9 million people.⁵³ These standards have then been adapted and integrated into a comprehensive plan at a more local level for a population of about 92 000 young people.⁵⁴ National health guidelines for asthma management improve outcomes across different socioeconomic settings, for example in Finland, Brazil, and Poland.⁵⁵

5.2 | Changes needed in global clinical asthma care

All countries must have a trained, available workforce to deliver appropriate care for each child with asthma. We need quality standards applicable worldwide, adapted for individual countries to account for local factors.¹³

Asthma education in primary care saves lives and reduces health costs.⁵⁶ Improving diagnostic accuracy must first be addressed, using a clear educational strategy. Guidelines need simplification for primary care with recommendations on how to monitor asthma control and future risk. Asthma outcome data must be used to assess care, focusing on improving asthma control, and reducing future attacks and asthma deaths,⁵⁷⁻⁶⁰ as was done to assess progress against the Millennium Development Goals.⁶¹ Most children can achieve asthma control simply by the use of inhaled low dose ICS and SABAs via a metered-dose inhaler (MDI) and spacer.⁶²

All children should have access to care that meets their needs, including clean air and a smoke-free environment. Clean air encompasses not merely industrial and other environmental pollutants, but also freedom from exposure to second-hand tobacco smoke and the effluvia from e-cigarettes, especially if these have been “cut” with substances of abuse or other illicit contaminants.

There must be access to local guidance-recommended, affordable treatment, developed and supported by local children's asthma champions. The International Primary Care Respiratory Group has developed a “Teach the Teacher” program, to build capacity for evidence-based practice and teaching/learning strategies appropriate to primary care. The model has been tested in eight countries for use in adults with asthma.⁶³ The group has now developed a three-tier program with a clinical focus on children's asthma. Key primary care health professionals have attended inter-disciplinary international workshops to gain the skills and knowledge required to adapt the curriculum and materials, and develop and lead in-country appropriate programs. These are cascaded to healthcare educators in the community and in and across primary care. These educators deliver relevant modules within their communities, assessing progress by collecting and sharing data (www.theipcr.org).

5.3 | Changes needed in policy

Policies must ensure all children have access to affordable basic asthma care within their local communities.^{64,65} All asthma outcomes must be monitored centrally.

Communication between health care teams can be greatly improved. Primary care visits may, of necessity, be short. Information from asthma specialists may not automatically be shared with the primary care team. A school nurse (if such a person exists, and if the child actually attends school) may recognize clinical problems but be unable to contact other health care workers. Asthma management plans should be copied to schools to coordinate care. Poor communication can result in different treatment plans from different teams,

confusion, unnecessary costs, and bad outcomes.^{58,66} New technologies can improve asthma self-management with families having direct access, through their electronic health record, to their community healthcare professionals. They could help enable prompt primary care review after hospital discharge. We need research into better asthma communication between patients, primary care physicians, asthma specialists, teachers, and community health care professionals.

5.4 | Schools

Self-management educational interventions improve lung function and decrease some measures of morbidity and healthcare use in children and adolescents with asthma.⁶⁷ Schools are important settings to offer asthma teaching and training to children. School nurses can recognize the need for referral to a primary care doctor or asthma specialist, uncover the social or psychological issues which are affecting asthma control and provide an important support system by contributing to the medical education of the child and the family. They can also educate the whole school community.

Teachers need to know how to respond to an asthma attack and help counteract stigma. They need up to date asthma information and knowledge of available resources. Many countries do not have school nurses, but professionals other than nurses can be identified and trained to undertake a similar role. Directly-observed therapy using community workers functions well in tuberculosis management and could be extended to asthma. Many community pharmacists want involvement in this process. We need to develop asthma champions from varied backgrounds depending on the locality.

School-centered programs can identify those with uncontrolled asthma, help them understand and monitor their asthma better, relate with healthcare providers,^{62,63} and reduce attacks and school absences.⁶⁸⁻⁷¹ Trained community health workers can assist school nurses.⁷² However, in many countries, schooling is far from universal, and this is where the local community “asthma champion” has a role, identifying children who are not at school and advocating for them.

An asthma management program, SAMPRO,⁷³ has developed a tool kit to support schoolchildren with asthma in the USA. It provides a school asthma management plan, addresses home environmental trigger factors and monitors asthma school absences. Other countries have similar programs.

5.5 | Poverty

Poverty, neighborhood violence, maternal anxiety, depression in pregnancy, and childhood stress all significantly affect asthma outcomes.⁷⁴⁻⁷⁷ Community programs must address such issues. Once started, such programs often find innovative ways to develop and progress.^{78,79} It is possible to improve asthma control using different

methods. An individual tailored, multifaceted intervention by social workers reduced asthma symptoms amongst inner-city children,⁸⁰ and a detailed review of seven successful interventions have also been reported.⁸¹ Other detailed summaries addressing asthma disparities have demonstrated multiple successful interventions.^{64,82}

Ambitious implementation studies are needed to test whole systems approaches to “at-risk” families. Important lessons are available from the Seattle Healthy Homes Project where greater improvements were noted with a high intensity as compared to a low-intensity program.⁸³

5.6 | Environment

A recent systematic review identified 35 well-designed studies from North America, Europe, and China assessing the impact of smoke-free legislation on child health with clear benefits on hospital admissions and improved asthma control.⁸⁴ A Cochrane review of interventions to reduce childhood ETS exposure (including 11 from LMICs) found that a few interventions reduced children's exposure to ETS and improved children's health. Features of effective interventions were not clearly definable.⁸⁵ Provision of better housing improved asthma symptoms and severity of disease in children in Massachusetts.⁸⁶

5.7 | Improved health care communication

Applying real-world primary care data can help predict asthma attacks and can help to improve asthma control in children.⁸⁷ The British Lung Foundation asthma management program involving 2800 children with asthma demonstrated significant improvement in asthma control after educational intervention.⁸⁸

There are already examples of how data can create maps of areas of deprivation in growth failure and education, and also how to reduce the burden of respiratory infection, all highly relevant to asthma.⁸⁹⁻⁹² Although important themes such as increasing immunization cover and reducing indoor pollution emerged, it was clear that preventive measures needed to be individualized; one size certainly did not fit all.

There is strong evidence that better communication following integrated, multifaceted practice-based approaches for patient management, improves outcomes and reduces the need for referral to secondary care. Coordinated practice systems combining several interventions (such as decision support tools, flagging of electronic records, use of care pathways, staff training and structured approaches to patient education) afford the greatest benefits.^{1,2,93,94}

Matrix-support collaborative care (which includes training and support for primary care physicians/nurses from specialists including joint consultations, case discussions, and tailored education), is well-accepted by primary care professionals and reduces respiratory secondary care referrals.⁹⁴ One such approach was in a deprived area of inner-city London, called “Connecting Care for Children”

(<https://www.cc4c.imperial.nhs.uk/>). This model of outreach by hospital paediatric specialists to primary care/hubs to build competence and confidence through case discussion and also offer individual consultations has been shown to yield a very positive impact on walk-in emergency attendances.⁹⁵ Such an approach may reduce subsequent all-cause emergency room attendances by half.⁹⁶

A Cochrane review in both HICs and LMICs showed the use of community health care workers was a cost-effective intervention for childhood asthma.⁹⁷ This may be a good strategy to strengthen asthma care in LMICs with limited medical or nursing personnel.

As children from deprived areas may make greater use of unplanned emergency care, it is important to provide proactive and protocol-driven emergency department care. A Cochrane review showed fewer admissions and hospital attendances following the education of the carer and/or child in the emergency department.⁹⁸ Given the association between deprivation, asthma triggers, and hospital attendance, guidance on how to avoid asthma triggers at home is recommended as part of the intervention (eg, smoking cessation advice).

Continuity of care is likely to be important to reduce the frequency of hospital admissions.⁹⁹ Primary care offers this opportunity and can be underpinned by an electronic health record, or patient-held record to facilitate continuity of decision-making. Lower continuity of primary care has been associated with more hospital admissions in children,¹⁰⁰ and in children and adults enrolled in a Medicaid program.¹⁰¹

Even in areas of conflict, it is possible to improve systems of care. In Syria, war shelters are now integrated into the system of care to ensure essential anti-inflammatory inhaled medicines are available.¹⁰² Also, in a systematic review, quality improvement interventions have been shown to improve outcomes in children with asthma.¹⁰³

5.8 | Research priorities

Research is needed to persuade governments that there are better ways to diagnose and manage asthma in children. We need targeted research into better diagnosis, particularly in younger children, with a review of new and existing biomarkers to identify different endotypes. Exacerbation risk research is needed with the recognition that factors driving it will be different between and within high-income countries and LMICs. We should start by a meeting of policymakers to determine data requirements that are needed to facilitate policy changes which improve important outcomes.

How do we move from a global philosophy where management of acute attacks is the priority to one where longitudinal care or preferably prevention of symptom development is the rule? We now have measures of asthma burden such as the Composite Asthma Severity Index and Asthma Severity Scoring System¹⁰⁴⁻¹⁰⁶ and tools to predict who is at risk for seasonal exacerbations.^{36, 37} These tools need studying and probably modifying in LMICs. Ultimately, we need to progress toward a primary prevention strategy for childhood asthma, which should be part of the research plan.

Asthma data are inadequately collected at a national level with no global international vision. In contrast, the success of the cystic fibrosis registries and their quality improvement programs is enviable.^{107,108} Setting up local, national, and global severe children's asthma registries will help, progressing then to other asthma categories. These registries should contain longitudinal information on lung trajectories, the frequency of asthma attacks, medication adherence patterns, patient behaviors, and environmental details.

Further research into the feasibility of an international standard for asthma care is needed with transparent benchmarks for diagnosis, management outcomes and medications prescribed, organized and funded at a national level and data shared with international registries, similar to that developed for adults with severe asthma.¹⁰⁹ It will improve asthma care¹¹ and inform policymakers. Financial support is required for the implementation of minimal standards together with real world-research into its outcomes.

Technology advances will enable electronic medication monitoring, as well as the organization of medical records to identify those children with frequent hospital admissions. Such technology could be used to identify children receiving suboptimal care. While these potential advances may not be available in LMICs, they are feasible in high-income countries containing deprived communities. The asthma community needs to encourage research into these techniques. If benefits are shown, such advances will enter into asthma guidelines with subsequent adaptation in both high income and LMICs. Table 4 summarises the key elements of research policy and public expectation needed to really make a difference.

6 | CONCLUSIONS

Our recommendations enable us to examine the understanding of global asthma in children in a comprehensive way. Table 2 sets out measurable next steps to improve asthma diagnosis and management in a way which is adaptable to each individual country.

The current approach requires supplementation with new, collaborative, community-based approaches that work toward more

TABLE 4 The future clinical, research, and policy direction for asthma in children

- We support research for new biomarkers which are inexpensive and useable on a global scale, particularly for the noneosinophilic asthmas.
- We endorse the global public expectation that children will be correctly diagnosed, treated and regularly reviewed with appropriate monitoring of their asthma control.
- We urge politicians to support this and recognize that children's health will benefit hugely and the overall cost of asthma care will fall.
- We recognize that early prevention of airway disease is a major global health goal.
- We call for access to affordable preventive therapy for all children.
- We call for clinicians to approach asthma in children as a potential cause for adverse respiratory effects in adulthood.

acceptable standards of asthma care for all. By directing attention to the risk domain, future asthma attacks can be reduced together with the consequent risk of disease progression and the associated irrecoverable loss of pulmonary function.

TABLE 5 Building blocks to reduce worldwide morbidity and mortality in children with asthma

A: Local requirement

- Choose an asthma champion within a health care system to lead and implement a population health model including prevention and treatment of children using tobacco products and e-cigarettes.
- Ensure full recognition that an asthma attack is a risk factor for a future asthma attack and must lead to a reevaluation of asthma care to prevent further attacks
- Build a registry of children with moderate to severe asthma.
- Follow each child's asthma life-course with repeated lung function trajectory measurements, especially those with moderate to severe asthma characterized by frequent asthma attacks.
- Utilize assessments, which may need local adaption, for example, the Composite Asthma Severity Index (CASI) to identify children with the greatest burden of asthma.
- Support the establishment of school nurses or other local asthma champions, such as community health workers, in all schools to support asthma management.
- Adopt a population asthma management strategy locally and implemented regionally using community resources.
- Develop a registry run by academic centers to coordinate data collection for national and international collaboration to increase understanding of mechanisms relating to asthma onset and progression.

B: National requirement

- Using the Global Initiative for Asthma (GINA) as a template, develop national guidance individualized to enable regulatory approval of effective medications.
- Develop teaching capacity particularly in primary care to ensure that knowledge transfer leads to clinical behavioral change. Consider the "Teach the Teacher" model from the International Primary Care Respiratory Group; the curriculum of which is adaptable for local needs.
- Standardize quality of care within health care systems and academic centers to enable reimbursement based on quality improvement.
- Identify children with a high burden of asthma and ensure the availability for asthma specialist referral.
- Set up process to monitor outcomes across health care systems to define standards of care and improve quality.

C: International requirement

- The Global Initiative for Asthma (GINA) strategy should continue as the basis for effective asthma management but be modified and simplified as needed by individual countries with increased participation from primary care.
- The global strategy should be child-centred and adapted for implementation in the community.
- Guidance on "difficult to treat asthma" needs regular review based on the introduction of newer medications or management strategies.
- Strategies are needed to ensure primary care clinicians and their support staff, including community health workers, are trained and confident to manage children with mild to moderate asthma with clear pathways for specialist referral if the asthma is not responding to low dose treatment.

- The World Health Organization should monitor the use of appropriate medications including inhaled corticosteroids and rescue therapy and spacers and encourage their availability in all countries but particularly in low and middle-income countries (LMICs).
- Each country should ensure there is sufficient knowledge and support for primary care physicians to successfully manage asthma.
- An international collaborative of academic centers is required to facilitate research into the geographic differences of asthma in children.
- The international collaborative should harmonize terminology and data collection systems to enable research into the components of asthma including the effect of interventions and management strategies.
- This international collaborative should publish data which will inform GINA and the asthma community as a whole on the worldwide asthma management in children and recommend variations according to regional differences.

Note: The Tables set out broad general principles, but the detailed practical implementation will depend on the setting, and should be determined in partnership between local communities and health care professionals.

Asthma clinicians in all countries need a better understanding of their local "asthmas" to facilitate local network strategies to increase access to basic asthma care. This will influence governments to recognize the benefits. Academic centers should develop higher national standards of care alongside the Global Asthma Network and the WHO. All should work with national governments to convince them care and outcomes can improve if training and education in childhood asthma are optimized. If the local, national, and international building blocks in Table 5 (A, B, and C) are put in place, it is likely that the remarkable outcomes of reduction in asthma morbidity and mortality seen in Finland can also be realized globally.

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CONFLICT OF INTERESTS

SJS reports acting as a consultant for and research with Boehringer Ingelheim, GlaxoSmithKline plc, AstraZeneca, Novartis, Regeneron, and Sanofi and grants from GlaxoSmithKline plc and Propeller Health. DAF has consulted for GlaxoSmithKline plc and Merck, Sharp & Dohme. YA reports grants from Astellas, GlaxoSmithKline plc, and Pfizer and personal fees from Merck Sharp & Dohme, GlaxoSmithKline plc, and Kyorin Pharmaceuticals. MF and WL are former GlaxoSmithKline plc employees and hold GlaxoSmithKline plc shares. SP reports personal fees from AstraZeneca, ALK, Thermo Fisher Scientific, and Phadia. AØ has consulted for GlaxoSmithKline plc and Boehringer Ingelheim. HJZ reports grants from The Allergy Society of South Africa, South Africa Medical Research Council and acting as a consultant to GSK. All other authors have no competing interests to disclose.

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AUTHOR CONTRIBUTIONS

All authors were involved in the development of this manuscript and approved the submitted version.

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ON BEHALF OF THE CHILDREN'S ASTHMA GROUP

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