PRIMARY IMMUNODEFICIENCY IN CHILDHOOD

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Abstract: Primary immunodeficiencies (PIDs) represent a heterogeneous group of genetic diseases that compromise the function of the immune system, especially in childhood, when they are most frequently diagnosed. This qualitative and exploratory study investigates the challenges related to early diagnosis, clinical management and inequalities in access to treatment in the Brazilian context. The methodology was based on a bibliographic review of articles published in the last ten years, in Portuguese and English, analyzed using the content analysis technique. The results highlight the relevance of strategies such as neonatal screening, increased access to advanced therapies and training of health professionals for the early identification of PIDs. It was also identified that regional inequalities and the lack of integrated public policies limit advances in the care of these patients. It is concluded that investments in infrastructure, education and research are essential to overcome existing barriers and improve clinical outcomes, promoting greater equity and effectiveness in the management of PIDs.

Keywords: primary immunodeficiencies, childhood, early diagnosis, clinical management, public policies.

INTRODUCTION

Primary immunodeficiencies (PIDs) are a heterogeneous group of genetic diseases that

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affect the immune system, compromising the body's response to infectious agents and increasing susceptibility to autoimmune diseases and malignancies. These conditions, usually diagnosed in childhood, can manifest themselves through recurrent, severe and difficult-to-treat infections, as well as non-infectious symptoms, such as hematological and inflammatory changes. Early diagnosis is crucial, as it allows for appropriate therapeutic interventions, such as immunoglobulin replacement and bone marrow transplantation, which can significantly improve the prognosis and quality of life of patients (FONSECA et al., 2015). Despite diagnostic and therapeutic advances in recent decades, underreporting and late diagnosis are still recurrent problems, especially in developing countries, where access to specialized services is limited (OLIVEIRA et al., 2017).

In addition to the direct impact on patients' health, PIDs represent a challenge for health systems, due to the high cost associated with clinical management and the complications resulting from late diagnosis. Recent studies have demonstrated the relevance of newborn screening programs for the early identification of some PIDs, such as severe combined immunodeficiency, although these programs are not yet widely implemented in many countries, including Brazil (PEDROSA et al., 2019). In addition, the limited understanding of the general population and even of some health professionals about the severity and manifestations of PIDs contributes to the delay in clinical recognition and referral to referral centers, increasing inequalities in access to treatment (SANTOS et al., 2020).

The complexity of PIDs requires a multidisciplinary approach, integrating pediatricians, immunologists, geneticists, and other specialists. In addition, the advancement of molecular diagnostic technologies has allowed the identification of new genetic variants associated with PIDs, expanding the clinical spectrum of these conditions and enabling more personalized treatments (MARTINS et al., 2021). However, the incorporation of these technologies into clinical practice faces barriers, such as high cost and lack of laboratory infrastructure in several regions. Given this scenario, it is essential to strengthen the training of health professionals and expand research on the epidemiology, diagnosis, and management of PIDs, especially in resource-limited contexts (ALMEIDA et al., 2020).

The gap between scientific knowledge and clinical practice in the diagnosis and treatment

of primary immunodeficiencies in childhood raises concerns Although significant advances have been made, many cases continue to be underdiagnosed or diagnosed late, which increases infant morbidity and mortality and compromises the quality of life of patients and their families. Therefore, the question that guides this study is: how to improve the early diagnosis and clinical management of primary immunodeficiencies in childhood in the Brazilian context, considering the limitations of resources and inequality in access to health?

The general objective of this study is to analyze the barriers and opportunities for early diagnosis and effective management of primary immunodeficiencies in childhood in Brazil. The specific objectives include: (1) to investigate the main factors associated with the late diagnosis of PIDs in children, (2) to evaluate the effectiveness of public health policies in promoting the diagnosis and treatment of PIDs, and (3) to propose strategies for the implementation of neonatal screening programs and training of health professionals in the early detection of these conditions.

The study of primary immunodeficiencies in childhood is extremely relevant due to the significant impact of these conditions on infant morbidity and mortality, as well as on costs to health systems. In a scenario where early diagnosis can save lives, identifying gaps in care processes is a key step in improving the prognosis of these patients. Brazil, with its extensive population diversity and inequality in access to health, offers a unique context for the analysis of PIDs, allowing the identification of specific challenges and the development of solutions adapted to local realities (CARVALHO et al., 2016).

In addition, advances in knowledge about PIDs can generate benefits that go beyond the field of immunology, contributing to the improvement of public health policies and the strengthening of specialized care networks. The evidence generated by this study can help raise awareness among health managers and formulate strategies that reduce the burden of PIDs in childhood, promoting greater equity in access to diagnosis and treatment (LIMA et al., 2018).

METHODOLOGY

This study adopts a qualitative and exploratory literature review methodology, with the objective of mapping and analyzing relevant publications on primary immunodeficiencies (PIDs) in childhood, considering the dimensions of diagnosis, clinical management, and health policies. The qualitative approach was chosen because it allows an in-depth analysis of the contents and perspectives presented in the selected studies, while the exploratory approach seeks to broaden the understanding of the theme by identifying gaps in knowledge and proposing directions for future research. To ensure the representativeness and timeliness of the data, the inclusion criteria were: articles published in Portuguese and English in the last 10 years (2013-2023), available in open or institutional access, that specifically addressed PIDs in childhood, and were indexed in recognized scientific databases, such as Scopus, PubMed, SciELO, and VHL.

The search strategy was structured around keywords selected based on previous literature and the descriptors of the Virtual Health Library (DeCS/MeSH). Terms such as "primary immunodeficiency", "childhood", "early diagnosis", "clinical management", "primary immunodeficiency", "childhood", "early diagnosis" and "clinical management" were used, combined by Boolean operators (AND, OR and NOT) to refine the results. The initial search resulted in a total of 1,220 articles. After applying filters related to language, year of publication, and thematic relevance, 176 studies were selected for abstract reading. Of these, 58 articles fully met the inclusion criteria and were analyzed in full. The critical reading of the full texts was carried out based on a previously structured analytical script, contemplating the objectives of the study and the methodological aspects, results and conclusions of the articles.

The data analysis was conducted based on the content analysis technique proposed by Bardin (2011), which allows the identification of thematic categories and patterns in the information presented. The results were organized into three main axes: (1) early diagnosis and neonatal screening, (2) clinical management and available therapies, and (3) public policies and inequality in access to treatment. This

categorization sought to integrate the different perspectives identified in the articles, highlighting both the advances and the gaps in the field of PIDs. The triangulation of sources, involving the comparison between studies carried out in different geographic and sociocultural contexts, was fundamental to ensure the validity of the findings and to understand how local factors influence the challenges and opportunities in the diagnosis and treatment of PIDs.

DEVELOPMENT

Early Diagnosis of Primary Immunodeficiencies in Childhood

Early diagnosis of primary immunodeficiencies (PIDs) in childhood is one of the main strategies to improve clinical outcomes and quality of life for patients. PIDs often present with nonspecific initial manifestations, such as recurrent and severe infections, making their identification difficult without specialized knowledge. Studies indicate that newborn screening for conditions such as severe combined immunodeficiency (SCID) has been shown to be an effective approach to identify affected children early, allowing interventions such as hematopoietic stem cell transplantation before the emergence of serious complications (PEDROSA et al., 2019).

However, implementation of this strategy is limited in low- and middle-income countries due to financial and logistical barriers. In addition, the lack of awareness among health professionals contributes to delays in diagnosis, highlighting the need for educational programs aimed at pediatricians and generalists, who are often the first to see these patients (OLIVEIRA et al., 2017).

The early diagnosis of primary immunodeficiencies (PIDs) in childhood is one of the greatest challenges faced by public health in Brazil. Although there is consolidated knowledge about the warning signs for PIDs, their application in clinical practice is still insufficient. According to Moreira et al. (2015), most cases of PIDs in Brazil are diagnosed late, when the patient already has severe complications. The absence of widely disseminated national protocols aggravates this situation, especially in regions with low coverage of specialized services. Therefore, initiatives to disseminate

information about warning signs among health professionals are essential.

Newborn screening programs have been shown to be effective in diagnosing severe combined immunodeficiencies (SCID) in other countries, but their implementation in Brazil is still limited. Pereira et al. (2018) highlight that screening based on biomarkers such as TREC and KREC could significantly reduce the morbidity and mortality associated with these conditions. However, the national implementation of this program faces logistical and financial obstacles, especially in states with less economic development. The expansion of regional pilot programs would be an important step to prove their viability on a national scale.

The lack of knowledge about PIDs is also a barrier among health professionals themselves. In a study by Campos et al. (2020), 65% of the pediatricians interviewed reported never having received specific training on immunodeficiencies. This gap reflects the urgent need for continuous training programs, with a focus on identifying early signs and guiding referrals to specialized centers. Telehealth emerges as a promising tool to overcome access limitations in remote areas, allowing consultations with specialists and discussions of clinical cases in real time.

Regional inequality in access to diagnosis and treatment also deserves attention. According to Silva et al. (2017), children from states in the North and Northeast are more likely to have a late diagnosis compared to those from states in the Southeast and South, due to the lack of specialized laboratories and the absence of referral centers. To correct these inequalities, it is essential to create strategies that promote the decentralization of health services, enabling early diagnosis even in places far from large urban centers.

Technological advances, such as next-generation sequencing (NGS), have expanded the genetic diagnosis capacity of PIDs. However, studies such as that of Oliveira and Santos (2019) point out that the high cost of these tests is still a significant barrier in developing countries. The progressive incorporation of these technologies into the Unified Health System (SUS) would be a viable solution, as long as it is accompanied by investments in laboratory infrastructure and the formation of teams capable of interpreting the results.

In addition to expanding the implementation of newborn screening programs, it is essential that Brazil offers continuous and integrated support for the early identification of PIDs. The creation of digital platforms that integrate data from different health services, such as hospitals, clinics, and health centers, could contribute significantly to the effectiveness of these programs. With the use of electronic systems, it would be possible to store and analyze information more efficiently, allowing health professionals to detect signs of immunodeficiencies more accurately and quickly. The integration of artificial intelligence (AI) technologies could also be explored to aid in the analysis of laboratory tests and the detection of genetic anomalies, further enhancing the early screening of PIDs. (MOREIRA et al., 2015; PEREIRA et al., 2018).

Another point to be addressed is the need to improve the training of health professionals in relation to immunodeficiencies. The inclusion of content on the diagnosis and management of PIDs in undergraduate curricula in medicine and nursing is an essential measure to better prepare professionals to identify, diagnose and treat these rare conditions. Continuing education programs, with a focus on clinical immunology, could enable a greater number of professionals to offer quality care to patients with PIDs, reducing the number of late diagnoses. (CAMPOS et al., 2020; PEREIRA and OLIVEIRA, 2018).

The implementation of next-generation sequencing (NGS) technologies also represents a significant advance in improving the diagnosis of PIDs. This technology is able to perform faster and more accurate genetic testing, allowing for earlier identification of conditions. However, the high cost of these tests is still a barrier to be overcome in Brazil, where many health services face budget limitations. An interesting strategy would be the creation of partnerships between the public and private sectors, in order to facilitate the availability of these technologies on a large scale, contributing to better diagnostic coverage. (OLIVEIRA and SANTOS, 2019; FERREIRA and ROCHA, 2017).

It is important to highlight the need for public policies that effectively address regional inequalities in access to diagnosis and treatment of PIDs. Initiatives that promote the decentralization of health services, such as the creation of new referral centers in regions further away from large urban

centers, could considerably improve the coverage of early diagnosis. With the creation of more blood collection stations for neonatal screening, in addition to specialized care centers, it would be possible to reach a greater number of children who need specialized care. (SILVA et al., 2017; BARROS et al., 2020).

Clinical Management and Available Therapies

The clinical management of PIDs is challenging and depends on the specific type of immunodeficiency and the severity of the condition. In many cases, treatment is based on immunoglobulin replacement, which reduces the frequency of infections and improves clinical outcomes. However, advanced therapies, such as hematopoietic stem cell transplantation and gene therapy, have shown promise in providing a cure for certain PIDs, especially in children diagnosed early (MARTINS et al., 2021).

In Brazil, access to these treatments is still unequal, with large regional disparities in the availability of specialized centers and adequate infrastructure for complex procedures. In addition, the difficulties in establishing accurate genetic diagnoses represent another challenge, since many mutations that cause IDPs have not yet been fully characterized. The adoption of technologies such as next-generation sequencing (NGS) has the potential to transform the diagnosis and management of PIDs, but their high cost limits their large-scale use, especially in public health systems (ALMEIDA et al., 2020).

The clinical management of PIDs is an area that requires individualized interventions, given the heterogeneity of these conditions. Immunoglobulin replacement therapy remains the main approach for patients with hypogammaglobulinemia, as highlighted by Santos et al. (2016). This therapy, although effective, presents challenges in Brazil, especially related to distribution logistics and the training of professionals for its administration. The introduction of subcutaneous therapies at home has been explored as an alternative for patients in remote regions, reducing dependence on

hospital centers.

For more severe cases, such as combined immunodeficiencies, hematopoietic stem cell transplantation is considered the gold standard. Ribeiro et al. (2020) report that the success of this procedure is directly related to performing the transplant before the development of serious infections or irreversible damage. However, the lack of specialized centers in several regions of Brazil limits many children's access to this therapy, highlighting the need to expand and decentralize transplant services.

The development of advanced therapies, such as gene therapy, represents a significant opportunity for the treatment of PIDs. According to Almeida and Costa (2021), gene therapy has already demonstrated efficacy in conditions such as X-linked SCID. However, the incorporation of this technology in Brazil faces economic and structural challenges, including the lack of adequate laboratories and trained teams. Investment in international partnerships and the creation of reference centers for gene therapy research would be important steps to overcome these barriers.

Treatment adherence is another crucial aspect in the management of PIDs. In a study by Lima et al. (2018), it was identified that the lack of regular follow-up and low patient adherence are among the main factors that compromise clinical outcomes. Strategies such as continuing education for patients and caregivers and the use of health apps to monitor treatment can significantly improve these indicators.

The role of the SUS in providing treatments for PIDs is undeniable, but it faces structural and budgetary limitations. According to Ferreira and Rocha (2017), the demand for drugs and therapies for PIDs has grown rapidly, while the resources allocated to the sector remain insufficient. This reinforces the need for public policies that prioritize increasing funding and optimizing the logistics of drug distribution.

The clinical management of PIDs requires a multidisciplinary approach, considering the variability between the different types of immune deficiency and the individual response of each patient to treatment. For milder immunodeficiencies, such as hypogammaglobulinemia, intravenous

or subcutaneous immunoglobulin replacement is often sufficient to control recurrent infections and improve patients' quality of life. However, in more severe cases, such as severe combined immunodeficiency (SCID), which compromises multiple aspects of the immune system, more complex treatments, such as hematopoietic stem cell transplantation, are essential. These treatments not only improve patients' immunity, but, when performed early, can offer a real chance of cure, reducing the risk of fatal infections (RIBEIRO et al., 2020; SANTOS et al., 2016).

The scarcity of specialized centers and the lack of infrastructure to perform hematopoietic stem cell transplants in several regions of Brazil continue to be a significant obstacle in the treatment of children with PIDs. The centralization of these services in a few states of the country entails a great logistical challenge, since many families face financial and transportation difficulties to access these treatments, which can compromise the results. The expansion of specialized centers, as well as the training of professionals in different regions, could improve access to these essential treatments and reduce the regional inequality observed in the treatment of PIDs (FERREIRA and ROCHA, 2017; SILVA et al., 2017).

The introduction of subcutaneous immunoglobulin therapies has proven to be an interesting alternative, especially for patients in remote areas, where access to hospitals is more difficult. The possibility of performing treatment at home not only provides more comfort and autonomy for patients, but can also reduce hospital costs and improve treatment adherence. However, implementing this strategy requires adequate training for both healthcare providers and the patients and caregivers themselves to ensure that treatment is administered correctly and without complications. Education and ongoing support programs are essential to maximize the benefits of this treatment modality (SANTOS et al., 2016; LIMA et al., 2018).

Although hematopoietic stem cell transplantation is a promising procedure for the treatment of severe immunodeficiencies, its performance still faces limitations in Brazil, such as the scarcity of compatible donors and the high complexity of the procedure. Performing the transplant at an early stage, before the emergence of irreversible complications, such as severe infections, is crucial for the

success of the treatment. Raising awareness about the importance of early diagnosis and creating national stem cell donor registries could increase the chances of success of these transplants and reduce inequalities in access to treatment (RIBEIRO et al., 2020; MOREIRA et al., 2015).

Gene therapy, in turn, emerges as a promising solution to treat conditions such as X-linked SCID, offering the possibility of correcting the underlying genetic defect. Despite the advances of this technology, its implementation in Brazil still faces significant financial and structural barriers. The high demand for innovative treatments, combined with limited financial resources, makes it difficult to incorporate these therapies into the Unified Health System (SUS). The support of international partnerships and the creation of reference centers for the development and application of gene therapy are essential for these innovations to reach patients in an equitable and effective way (ALMEIDA and COSTA, 2021; OLIVEIRA and SANTOS, 2019).

Another challenge in the clinical management of PIDs is patients' adherence to treatment. The lack of regular follow-up and the difficulty of engagement on the part of families, especially in the most remote areas, can compromise long-term results. The use of technologies such as health apps, which help in monitoring treatment adherence, as well as continuous education for patients and caregivers, can substantially improve treatment adherence and, consequently, clinical outcomes. These digital tools can allow for closer monitoring of patients, optimizing management and ensuring that treatments are administered appropriately (LIMA et al., 2018; PEREIRA and OLIVEIRA, 2018).

The integration of new treatments with traditional care is an important strategy to optimize outcomes in the management of PIDs. The use of complementary therapies, such as infection control with prophylactic antibiotics and close monitoring of patients' health, should be considered part of a comprehensive approach. In addition, the role of multidisciplinary teams, composed of doctors, nurses, psychologists, and social workers, is essential to ensure that patients receive integrated care and that families receive the necessary support during treatment (MARTINS et al., 2021; CAMPOS et al., 2020).

It is imperative that the Unified Health System (SUS) increase its investments in drugs and

therapies for PIDs, given the growing demand and complexity of these treatments. The allocation of public resources for rare diseases, such as PIDs, should be a priority in public health policies, in order to ensure that all patients, regardless of the region in which they live, have access to quality treatments. The adoption of strategies to optimize distribution logistics and increase funding for the development of new treatments are essential steps to improve access and outcomes in the treatment of primary immunodeficiencies in Brazil (FERREIRA and ROCHA, 2017; BARROS et al., 2020).

Public Policies and Inequalities in Access to Treatment

Public policies play a crucial role in improving the diagnosis and treatment of PIDs, especially in resource-limited settings. Despite significant advances, such as the inclusion of diagnostic tests in the SUS for some PIDs, coverage is still insufficient to meet national demand. Regional inequality in access to specialized health services is a reflection of the structural disparities in the Brazilian health system, which particularly affect children in more remote regions and with less socioeconomic development (CARVALHO et al., 2016).

Neonatal screening programs, widely adopted in developed countries, remain incipient in Brazil, limiting the possibilities of early identification and effective interventions. In addition, training initiatives for health professionals are fragmented, and PID awareness campaigns are rare, resulting in significant underreporting of cases. To address these challenges, continuous investment is needed in integrated policies that promote equity in access to diagnosis and treatment, in addition to strengthening health care networks, with a focus on comprehensive care and reducing regional inequalities (LIMA et al., 2018).

The design and implementation of public policies aimed at PIDs are still incipient in Brazil. In a study by Araújo et al. (2019), it was pointed out that the lack of accurate epidemiological data makes it difficult to plan effective policies. The establishment of a national registry of patients with PIDs would be a valuable tool for mapping prevalence and guiding public health strategies.

Regional inequality in access to diagnosis and treatment of PIDs reflects the structural disparities in the Brazilian health system. According to Barros et al. (2020), while states in the Southeast have well-equipped referral centers, states in the North and Northeast lack basic infrastructure for laboratory diagnosis. The decentralization of specialized services and the creation of new regional care centers are urgent measures to reduce these inequalities.

Training of primary care professionals is essential to improve the identification and management of patients with PIDs. Pereira and Oliveira (2018) highlight that the lack of adequate training in undergraduate medicine and nursing results in underdiagnosis, especially in more remote areas. Policies that encourage the inclusion of content on PIDs in academic curricula could fill this gap, promoting greater awareness from the training of professionals.

Public awareness campaigns also play an important role in strengthening health policies aimed at PIDs. According to Silva et al. (2017), initiatives such as the dissemination of warning signs for PIDs and the promotion of regular pediatric consultations could increase early detection and improve clinical outcomes. The participation of patient associations in these campaigns is essential to amplify the voice of affected families.

The allocation of financial resources for PID screening and treatment programs is a constant challenge in Brazil. According to Martins and Souza (2020), although technological advances have expanded therapeutic options, public funding has not kept up with this progress. A review of health investment priorities, with a focus on rare diseases such as PIDs, is indispensable to ensure equitable access to scientific and therapeutic innovations.

Inequality in access to diagnosis and treatment of PIDs is also reflected in the disparities in human resources in the different regions of Brazil. In many locations, especially in rural areas and peripheral regions, there is a shortage of physicians specializing in immunology, pediatrics, and other related fields, which makes it difficult to make rapid and adequate diagnoses. The training of professionals, not only for the diagnosis, but also for the clinical management of these conditions, is a fundamental step to overcome this barrier. In addition, the creation of residency programs in pediatric

immunology in areas with a shortage of specialists could help reduce scarcity and improve the quality of care (CARVALHO et al., 2016; PEREIRA and OLIVEIRA, 2018).

One of the most effective strategies to address inequalities in access to specialized treatments is the regionalization of health. This implies the creation of referral centers for the diagnosis and treatment of PIDs in different regions of Brazil, with the use of telehealth technologies to increase the reach of these services. Regionalization not only improves access but also facilitates continuous, specialized care for patients who require regular follow-up. The implementation of this policy, however, depends on a strong commitment on the part of the government to redistribute financial and human resources to the neediest areas, which requires detailed planning and cooperation between different levels of public management (BARROS et al., 2020; LIMA et al., 2018).

In addition, it is crucial to implement newborn screening programs at the national level, following the example of countries with more robust health systems. In Brazil, newborn screening is still restricted to a limited number of diseases, and expanding this list to include primary immunodeficiencies could mean the difference between a saved life and the development of serious complications. Early screening allows for immediate intervention, which is essential to prevent infections and other complications associated with PIDs, increasing the survival and quality of life of patients (LIMA et al., 2018; CARVALHO et al., 2016).

Health education, especially in the context of rare diseases such as PIDs, plays a crucial role in sensitizing the population and health professionals. However, the lack of awareness campaigns and the scarcity of information about these conditions contribute to the low rate of early diagnosis and the underreporting of cases. The inclusion of topics related to PIDs in community-oriented educational programs, such as schools and health centers, as well as the use of traditional and digital media, can significantly contribute to improving the population's knowledge about these diseases and their early signs (SILVA et al., 2017; PEREIRA and OLIVEIRA, 2018).

Partnerships with non-governmental organizations (NGOs) and patient associations are also essential to strengthen the implementation of public policies aimed at PIDs. These organizations

play an active role in educating patients and families, advocating for improved health services, and promoting support networks for those affected by these conditions. Strengthening these partnerships can be decisive for the voice of patients to be heard and to push for a real change in public health policies, ensuring that PIDs receive the attention they deserve within the national health system (ARAÚJO et al., 2019; SILVA et al., 2017).

It is critical that Brazil adopts an integrated, multisectoral approach to addressing inequalities in access to treatment for PIDs. This includes the articulation between health, education, and social assistance policies, in order to create an environment conducive to early identification, appropriate treatment, and continuous follow-up of patients. Effective coordination between different levels of government, non-governmental organizations, and civil society will be crucial for building a fairer and more equitable health system, capable of reducing regional inequalities and ensuring that all patients with PIDs have access to quality treatment, regardless of their location or socioeconomic status (MARTINS and SOUZA, 2020; ARAÚJO et al., 2019).

FINAL CONSIDERATIONS

The study of primary immunodeficiencies (PIDs) in childhood highlights the complexity and challenges involved in early diagnosis, clinical management, and the formulation of public policies aimed at this condition. It is observed that, despite advances in diagnostic technologies, such as next-generation genetic sequencing, and in the development of innovative therapies, such as gene therapy, many patients continue to face significant barriers to access appropriate treatment, especially in middle-income countries, such as Brazil. Underreporting and late diagnosis, largely caused by the lack of awareness and training of health professionals, aggravate the situation, increasing morbidity and mortality and costs for health systems.

In addition, the inequality in access to specialized services and cutting-edge technologies highlights the need for structured actions that promote greater equity in the care of these children. The

expansion of newborn screening programs, the strengthening of primary health care networks, and the creation of educational strategies for doctors and health teams are key interventions to reduce these disparities. At the same time, integrated public policies, which combine investments in infrastructure, development of national research, and awareness of society, are essential to address the challenges posed by PIDs and improve clinical outcomes and quality of life for patients.

Therefore, it is imperative that health systems adopt a proactive, interdisciplinary, evidence-based approach to address gaps in the diagnosis and treatment of PIDs. Investing in research, infrastructure and education will contribute to the early detection and more effective management of these conditions, ensuring better prospects for affected children and their families. This approach will not only benefit patients but also strengthen healthcare systems, making them better prepared to deal with complex and rare diseases like PIDs.

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