International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Operating Publisher
SciFormat Publishing Inc.
ISNI: 0000 0005 1449 8214

2734 17 Avenue SW,
Calgary, Alberta, T3E0A7,
Canada
+15878858911
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ARTICLE TITLE	HYPERTENSION IN CHILDREN WITH OBESITY: A COMPARISON OF THE EFFECTIVENESS OF PHARMACOTHERAPY AND LIFESTYLE MODIFICATION
DOI	https://doi.org/10.31435/ijitss.2(50).2026.5851
RECEIVED	02 April 2026
ACCEPTED	12 June 2026
PUBLISHED	26 June 2026
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HYPERTENSION IN CHILDREN WITH OBESITY: A COMPARISON OF THE EFFECTIVENESS OF PHARMACOTHERAPY AND LIFESTYLE MODIFICATION

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ABSTRACT

Aim: Hypertension in children with obesity is an increasingly common clinical problem characterized by complex pathophysiology and an early potential for target organ damage. The aim of this study was to compare the effectiveness of pharmacotherapy and lifestyle modification in the treatment of hypertension in children with obesity, taking into account the impact of both strategies on blood pressure levels, weight reduction, target organ damage, metabolic profile, treatment safety, and the durability of disease control.
Materials and methods: A narrative review of the structured literature was conducted, incorporating clinical guidelines, systematic reviews, meta-analyses, randomized controlled trials, cohort studies, and cross-sectional studies retrieved from PubMed/MEDLINE, PubMed Central, Cochrane Library, Embase, and Web of Science. Publications addressing epidemiology, pathophysiology, the effectiveness of non-pharmacological and pharmacological interventions, and their impact on target organs were included.
Results: The analysis indicates that lifestyle modification, including weight reduction, increased physical activity, dietary improvement, and reduced sedentary behavior, acts directly on the underlying cause of the disease and improves the metabolic profile, although it requires a longer time to achieve its full effect. Antihypertensive pharmacotherapy, particularly ACE inhibitors and ARBs, acts more rapidly and predictably, which is especially important in patients with stage 2 hypertension, symptomatic disease, target organ damage, or concomitant diabetes and chronic kidney disease.
Conclusions: The greatest clinical benefit is achieved with combined treatment, which integrates rapid hemodynamic control with simultaneous intervention on obesity and other components of cardiometabolic risk. The findings indicate that non-pharmacological treatment should form the foundation of therapy in every child with obesity and hypertension, whereas pharmacotherapy should be introduced in high-risk situations or when lifestyle interventions are insufficiently effective. The optimal management model requires individualization, interdisciplinary care, and long-term monitoring.

KEYWORDS

Pediatric Hypertension; Childhood Obesity; Obesity-Related Hypertension; Lifestyle Modification; Pharmacotherapy; Target Organ Damage

CITATION

Anita Strzykała, Igor Szlegiel, Oktawia Gwiaździńska, Jakub Lewandowski, Denis Myszak. (2026) Hypertension in Children with Obesity: a Comparison of the Effectiveness of Pharmacotherapy and Lifestyle Modification. *International Journal of Innovative Technologies in Social Science*. 2(50). doi: 10.31435/ijitss.2(50).2026.5851

1. Introduction

Hypertension in children and adolescents is no longer considered a marginal clinical entity and is currently recognized as one of the most important cardiovascular complications of pediatric obesity [1,3,4]. The prevalence of elevated blood pressure and hypertension in the pediatric population is estimated at approximately 3–5%; however, among children with overweight or obesity, the prevalence increases substantially and may exceed 10%, reaching as high as 20–25% in certain cohorts [2,4,24].

The clinical relevance of this phenomenon stems not only from its increasing prevalence but also from the observation that hypertension diagnosed during childhood frequently persists into adulthood [2,3]. The phenomenon of blood pressure tracking indicates that children with blood pressure values in the upper percentile ranges are more likely to develop sustained hypertension in early adulthood, accompanied by increased cardiovascular risk and a greater likelihood of premature target organ damage [2,33].

The pathophysiology of obesity-related hypertension in children is multifactorial and involves hemodynamic, neurohormonal, metabolic, and inflammatory mechanisms [3–5]. Central contributors include activation of the sympathetic nervous system and the renin–angiotensin–aldosterone system, sodium retention, hyperinsulinemia, insulin resistance, and an unfavorable adipokine profile. Together, these alterations promote increased peripheral vascular resistance, intravascular volume expansion, and vascular remodeling [3,4,6].

In contrast to secondary hypertension, which predominates in younger children, adolescents with obesity are most commonly diagnosed with primary hypertension closely associated with an adverse metabolic phenotype [1,2]. In clinical practice, hypertension in this population frequently coexists with visceral obesity, dyslipidemia, hyperuricemia, impaired glucose tolerance, non-alcoholic fatty liver disease, and obstructive sleep apnea, all of which further amplify overall cardiovascular risk [3,4,26].

Importantly, even relatively short exposure to elevated blood pressure may result in measurable target organ damage in pediatric patients [6,7]. Left ventricular hypertrophy has been reported in a substantial proportion of children with primary hypertension, while those with concomitant obesity exhibit a higher prevalence of structural and functional cardiac abnormalities compared with their normal-weight peers [6,10,25].

Beyond cardiac involvement, early manifestations of vascular injury have also been identified, including increased carotid intima–media thickness, greater arterial stiffness, and endothelial dysfunction [7,10]. These findings suggest that hypertension in children with obesity should not be regarded merely as a transient blood pressure abnormality but rather as a condition requiring active therapeutic intervention aimed at reducing long-term cardiometabolic risk [6,7,9].

Lifestyle intervention remains the cornerstone of treatment and includes weight reduction, dietary modification, increased physical activity, improvement of sleep hygiene, and reduction of sedentary behaviors [1,14]. Current pediatric guidelines emphasize that lifestyle modification should be considered first-line therapy in children with primary hypertension and obesity, as it targets not only blood pressure levels but also the underlying pathophysiological mechanisms of the disease [1,14,20].

The efficacy of lifestyle-based interventions has been confirmed in interventional studies and meta-analyses, although the magnitude of benefit depends on the type of intervention, its duration, and adherence to therapeutic recommendations [14,15,21]. Pharmacological therapy, in turn, provides more rapid blood pressure control and plays a particularly important role in patients with target organ involvement, symptomatic hypertension, stage 2 hypertension, or insufficient response to non-pharmacological treatment [1,17,19].

From a clinical perspective, the key question is not simply whether pharmacotherapy or lifestyle modification is more effective, but rather under which clinical circumstances each strategy offers the greatest benefit and when combined treatment should be implemented [14,17]. This issue is of considerable practical importance because, in some patients, the primary therapeutic goal is rapid normalization of blood pressure and prevention of further organ damage, whereas in others, long-term modification of the disease process through weight reduction and improvement of health behaviors may be of greater importance [6,14,17].

The aim of the present study is to compare the effectiveness of pharmacological treatment and lifestyle modification in the management of hypertension in children with obesity, with particular emphasis on their effects on blood pressure control, weight reduction, target organ damage, metabolic profile, treatment safety, and the achievement of sustained disease control [1,14,17]. An additional objective is to identify clinical factors that may help determine which patient groups can be effectively managed with non-pharmacological intervention alone and which require early initiation of antihypertensive pharmacotherapy [1,6,17].

2. Methodology

The present study was designed as a narrative literature review incorporating elements of a structured literature search, aimed at comparing the effectiveness of pharmacotherapy and lifestyle modification in the treatment of hypertension in children with obesity [11][13]. The search strategy, publication selection process, and presentation of results were developed in accordance with the PRISMA 2020 guidelines for transparent reporting of systematic reviews, as well as methodological recommendations outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* [11–13].

The literature search was conducted using the PubMed/MEDLINE, PubMed Central, Cochrane Library, Embase, and Web of Science databases, as these sources include clinical studies, systematic reviews, meta-analyses, and current scientific society guidelines [11][13]. The use of multiple databases was intended to minimize the risk of omitting relevant publications and to improve the comprehensiveness of the search strategy [11][12].

The search strategy was based on combinations of keywords and MeSH terms related to the pediatric population, obesity, hypertension, and therapeutic interventions [11][13]. The following search terms were used, among others: *pediatric hypertension*, *childhood hypertension*, *obesity*, *overweight*, *adolescents*, *lifestyle intervention*, *exercise*, *diet*, *weight reduction*, *pharmacotherapy*, *antihypertensive treatment*, *ACE inhibitors*, *ARB*, *calcium channel blockers*, *diuretics*, and *target organ damage* [11][13].

Publications involving children and adolescents were eligible for inclusion if they assessed the relationship between obesity and hypertension or evaluated the effectiveness of non-pharmacological and pharmacological interventions in this patient population [1][11][13]. Clinical guidelines, systematic reviews, meta-analyses, randomized controlled trials, cohort studies, and selected cross-sectional studies of particular relevance to epidemiology and target organ damage assessment were included in the analysis [1][6][7].

Eligible studies were required to meet at least one of the following criteria: provide data on the prevalence of hypertension among children with overweight or obesity; describe the pathophysiological mechanisms of obesity-related hypertension; evaluate the effectiveness of lifestyle modification in reducing blood pressure; report outcomes of antihypertensive pharmacotherapy in pediatric patients; or assess the impact of treatment on target organ damage [1][6][14][17].

Studies were excluded if they did not meet the predefined age criteria, focused exclusively on secondary hypertension unrelated to obesity, represented case reports, conference abstracts without full-text availability, articles with incomplete methodological data, or publications duplicating previously reported results without additional analytical value [11][13].

During the selection process, titles and abstracts of identified records were screened initially, followed by full-text assessment of studies considered potentially relevant [11][12]. At the full-text review stage, publications were evaluated with regard to thematic relevance, methodological quality, availability of quantitative data, and overall usefulness for addressing the primary objective of the manuscript [11][13].

Data extraction included authors, year of publication, study design, population characteristics, sample size, participant age, definition of hypertension, type of intervention, duration of follow-up, primary endpoints, and the most important quantitative findings [11][13]. In interventional studies, particular attention was paid to changes in systolic and diastolic blood pressure, effects on anthropometric parameters, metabolic outcomes, treatment safety, and adherence-related data [14][17][29].

The data analysis was qualitative and comparative in nature. Due to substantial heterogeneity among studies in terms of participant age, definitions of hypertension, duration of follow-up, intervention type, and study endpoints, no original meta-analysis was performed. Nevertheless, findings from previously published meta-analyses and systematic reviews were incorporated whenever their methodology was transparent and supported the synthesis of clinically relevant conclusions [11–13].

3. Results

3.1. Epidemiology and Pathophysiology of Hypertension in Children with Obesity

Hypertension in the pediatric population occurs significantly more frequently than was assumed only a decade ago and is currently recognized as one of the major cardiovascular risk components in childhood and adolescence [1][2]. Obesity remains the strongest modifiable risk factor for the development of hypertension in children and adolescents, and the relationship between BMI and blood pressure values is positive and progressive in nature [3–5].

Population-based data indicate that elevated blood pressure and hypertension are substantially more common among children with overweight and obesity than among their normal-weight peers [4][24]. This phenomenon is particularly evident in cases of more severe obesity, supporting the presence of a dose–response relationship between the degree of adiposity and the risk of abnormal blood pressure values [24][26]. Recent epidemiological evidence further suggests that, despite partial stabilization of hypertension prevalence in some pediatric populations, adiposity remains the dominant modifiable correlate of elevated blood pressure in both children and adolescents [3][28].

In clinical practice, the increasing prevalence of excessive body weight has substantially altered the profile of pediatric patients with hypertension. Hypertension is now more commonly encountered not as an isolated hemodynamic abnormality but rather as part of a broader cardiometabolic phenotype characterized by increased waist circumference, impaired glucose metabolism, dyslipidemia, and chronic low-grade inflammation [3][4][26]. Consequently, contemporary evaluation of children with elevated blood pressure should extend beyond isolated systolic and diastolic measurements and include assessment of central obesity, lifestyle-related factors, and coexisting metabolic disturbances [1][3][4].

The pathophysiology of obesity-related hypertension involves the interaction of several pathogenic mechanisms, including increased sympathetic nervous system activity, activation of the renin–angiotensin–aldosterone system, sodium retention, hyperinsulinemia, and insulin resistance [3–5]. Adipose tissue itself also plays a significant role as an active endocrine organ that secretes leptin, pro-inflammatory cytokines, and other mediators contributing to endothelial dysfunction, oxidative stress, and impaired blood pressure regulation [3][4][6].

From a hemodynamic perspective, obesity-related hypertension may develop as a consequence of increased intravascular volume, elevated cardiac output, and secondary increases in peripheral vascular resistance. Hyperkinetic circulatory mechanisms may predominate in the early stages; however, persistent disturbances eventually lead to vascular remodeling, reduced arterial compliance, and sustained dysregulation of blood pressure control [3][5][6]. Simultaneously, chronic sympathetic overactivity and prolonged stimulation of the renin–angiotensin–aldosterone axis further exacerbate sodium retention and reinforce the adverse feedback loop between obesity and hypertension [3][4].

Renal involvement also represents an important component of the disease process. Excess body weight increases filtration burden, promotes glomerular hyperfiltration, and impairs sodium excretion, thereby contributing over time to renal injury and further elevation of blood pressure [3][6][17]. This issue is particularly relevant in children with concomitant microalbuminuria, abnormal laboratory findings, or a positive family history of chronic kidney disease [1][6].

Childhood obesity is also strongly associated with additional metabolic abnormalities that amplify the detrimental effects of hypertension, including dyslipidemia, impaired glucose tolerance, hyperuricemia, non-alcoholic fatty liver disease, and obstructive sleep apnea [4][5][26]. The coexistence of these disorders is associated with a substantially higher risk of target organ damage compared with isolated hypertension [6][7]. This phenomenon is especially pronounced in patients with central obesity and a more advanced metabolic phenotype, in whom stronger associations are observed between blood pressure values and structural abnormalities involving the heart, vasculature, and kidneys [6][10].

In the pediatric population, increasing importance is currently attributed to ambulatory blood pressure monitoring (ABPM), as conventional office measurements may fail to identify all cases of clinically relevant hypertension [1][7]. Meta-analytic evidence has demonstrated that children with hypertension confirmed by ABPM have a significantly higher risk of left ventricular hypertrophy, increased arterial stiffness, and carotid intima–media thickening [7][10]. In children with obesity, ABPM is particularly valuable for detecting abnormalities in circadian blood pressure patterns, including impaired nocturnal blood pressure dipping, which may be associated with a less favorable target organ risk profile [30].

The role of ABPM extends beyond diagnostic confirmation alone. Twenty-four-hour monitoring allows for more accurate assessment of true blood pressure burden, facilitates detection of masked hypertension, and

improves estimation of target organ risk, which is especially useful in children with excessive body weight, in whom office blood pressure values may be variable and difficult to interpret [1][7][30]. From a therapeutic perspective, this suggests that treatment intensity should be determined not solely on the basis of isolated office measurements but also according to the overall circadian blood pressure profile [1][7].

Current epidemiological evidence supports the view that hypertension in children with obesity should be regarded as a highly prevalent disorder characterized by complex pathophysiology and an early potential for target organ damage [2][3][6]. These findings emphasize the need for early identification and implementation of effective therapeutic strategies before the development of irreversible cardiovascular and metabolic abnormalities [1][6][7]. At the same time, growing evidence indicates that effective intervention in this population may partially reverse the adverse consequences of both hypertension and obesity, further underscoring the importance of early treatment initiation [6][8][9].

3.2. Effectiveness of Lifestyle Modification

Lifestyle modification remains the cornerstone and recommended first-line treatment for hypertension in children with obesity, as it simultaneously affects blood pressure, body weight, and coexisting metabolic disturbances [1][14]. Unlike pharmacotherapy, non-pharmacological interventions directly target the pathogenic mechanisms underlying obesity-related hypertension, including sympathetic overactivity, insulin resistance, chronic inflammation, and endothelial dysfunction [3][4][14].

Physical activity represents the best documented component of non-pharmacological management [14][15]. Meta-analyses of randomized controlled trials involving children and adolescents with overweight or obesity have demonstrated that exercise-based interventions lead to significant reductions in both systolic and diastolic blood pressure, with the greatest benefits observed in programs characterized by higher intensity and longer duration [15][16]. One analysis including 19 randomized studies demonstrated significant reductions in both SBP and DBP, with greater effects observed among girls, patients with obesity, participants undergoing high-intensity interval training (HIIT), and those with a cumulative exercise duration exceeding 3000 minutes [15].

These findings are clinically relevant because they indicate that the antihypertensive effects of exercise are not merely marginal or theoretical but may be associated with clinically meaningful reductions in the risk of early target organ complications. Importantly, improvements in blood pressure following exercise programs do not occur in isolation but are accompanied by enhanced aerobic capacity, lower resting heart rate, and reductions in body weight or improvements in body composition, thereby strengthening the overall cardiometabolic benefits of intervention [15][16][21]. From a practical standpoint, physical activity should therefore be regarded not as an adjunctive component of therapy but rather as one of its central pillars [14][15].

Multicomponent interventions incorporating dietary modification, physical activity, and behavioral strategies are also of considerable importance [14][21][22]. Current evidence suggests that programs combining caloric reduction, improved dietary quality, increased daily energy expenditure, and psychological support demonstrate the greatest potential for lowering blood pressure and achieving sustained reductions in cardiometabolic risk [14][22][32]. The benefits of such approaches appear particularly pronounced when interventions involve the entire family and are integrated into the child's everyday environment rather than being limited to isolated counseling during outpatient visits [21][23][32].

Meta-analyses addressing obesity treatment in children indicate that lifestyle interventions may lead not only to reductions in BMI but also to improvements in metabolic parameters such as lipid profile, glucose metabolism, and cardiorespiratory fitness [21][22]. In the context of hypertension, these effects are particularly important because weight reduction often occurs in parallel with improved endothelial function and decreased neurohormonal activation, thereby enhancing the antihypertensive response [3][14][22]. Consequently, appropriately implemented lifestyle intervention simultaneously addresses the cause, mechanisms, and consequences of the disease.

The benefits of lifestyle modification extend beyond reductions in SBP and DBP and also include improvements in anthropometric parameters, physical performance, and autonomic function [15][16][21]. Clinically, this suggests that a well-designed non-pharmacological treatment program may exert antihypertensive, anti-obesity, and cardioprotective effects simultaneously [14][22]. Importantly, some studies indicate that careful selection of exercise modality, training intensity, and program duration may increase the likelihood of achieving clinically significant blood pressure improvement, supporting the need for individualized exercise recommendations rather than a universal therapeutic model [15][16][90].

Studies evaluating different forms of physical activity have shown that aerobic exercise, mixed training programs, and higher-intensity exercise may all contribute to blood pressure reduction in children with overweight and obesity [15][16][21]. Although current evidence does not yet identify a single unequivocally superior exercise model, most studies suggest that regularity, adequate training volume, and participant engagement are at least as important as the specific type of activity performed [15][19][21]. In clinical practice, this means that interventions should be tailored to the child's age, preferences, physical fitness, and family circumstances in order to maximize long-term adherence [14][29].

One of the major limitations of non-pharmacological treatment remains long-term adherence [14][23][29]. In outpatient settings, sustained modification of dietary habits, maintenance of regular physical activity, and reduction of sedentary behavior are often difficult to achieve, particularly when treatment does not adequately involve the family, school, and broader social environment [14][29][32]. Short-term success in reducing body weight or blood pressure does not necessarily translate into durable outcomes if interventions fail to produce meaningful behavioral change and are not supported by the patient's social environment [21][23].

The role of the family is especially important in this context. In younger children, intervention effectiveness depends largely on caregivers' willingness to modify dietary patterns, organize leisure activities differently, and reduce sedentary behaviors throughout the household [21][23][32]. Among adolescents, internal motivation, peer support, and therapeutic approaches that enhance self-efficacy rather than relying exclusively on restrictions and prohibitions may be of greater importance [14][29][32]. Therefore, the effectiveness of lifestyle intervention depends not only on the content of recommendations but also on how they are communicated and integrated into the patient's psychosocial context.

Despite these limitations, non-pharmacological treatment should remain the foundation of therapy for every child with obesity and hypertension [1][14]. In cases of mild primary hypertension and good therapeutic adherence, lifestyle intervention alone may provide clinically meaningful blood pressure reduction without the immediate need for pharmacological therapy [14][15]. Even when antihypertensive medication becomes necessary, continuation of lifestyle intervention remains essential because it is the only strategy capable of addressing the underlying cause of disease and reducing overall cardiometabolic risk in the long term [1][14][17].

3.3. Pharmacotherapy of Hypertension in Children with Obesity

Pharmacological treatment of hypertension in children with obesity is not considered first-line therapy in every case; however, in a subset of patients it is essential for achieving rapid blood pressure control and limiting the progression of target organ damage [1][17]. According to current guidelines, antihypertensive pharmacotherapy should be considered in children with symptomatic hypertension, stage 2 hypertension, persistent hypertension despite appropriately conducted lifestyle modification, as well as in the presence of chronic kidney disease, diabetes mellitus, or established target organ damage [1][2][19].

In the pediatric population, the principal classes of antihypertensive agents include angiotensin-converting enzyme (ACE) inhibitors, angiotensin II receptor blockers (ARBs), calcium channel blockers, and thiazide diuretics [1][17][18]. Drug selection should depend on the patient's clinical phenotype, the presence of comorbidities, safety profile, and the potential impact of a given therapeutic class on metabolic parameters and renal function [17–19]. In practice, this means that pharmacological treatment in pediatric patients requires a more individualized approach than in adults, taking into account not only blood pressure levels but also the child's developmental stage, treatment tolerance, and the potential long-term consequences of therapy [1][18].

Particular importance in children with obesity is attributed to ACE inhibitors and ARBs [17][18][27]. This is related to the fact that obesity-related hypertension frequently coexists with activation of the renin–angiotensin–aldosterone system, insulin resistance, and an increased risk of renal involvement; consequently, agents targeting this pathway may exert not only antihypertensive but also nephroprotective effects [3][17]. Their use appears especially justified in children with early signs of renal injury, proteinuria, or a pronounced metabolic burden, although therapeutic decisions should always be individualized and based on contraindications as well as careful safety monitoring [17–19].

A network meta-analysis of randomized trials involving children and adolescents with hypertension demonstrated that lisinopril, enalapril, and losartan represent effective therapeutic options for short-term blood pressure reduction [17]. Nevertheless, it should be emphasized that most pharmacological studies have relatively short follow-up periods, limiting the ability to fully assess the long-term impact of treatment on prognosis and regression of target organ damage [17][19]. Therefore, current evidence should be interpreted

as confirmation of the value of pharmacotherapy in short-term blood pressure control rather than proof that pharmacological treatment alone adequately addresses the entire cardiometabolic phenotype associated with obesity [17][18].

Calcium channel blockers and thiazide diuretics also remain important therapeutic options; however, in children with obesity, the metabolic profile of the selected medication is of particular relevance [18][19]. In some patients, diuretics may adversely affect glucose metabolism and electrolyte balance, highlighting the need for individualized therapeutic decisions [18]. Consequently, antihypertensive drug selection should not rely solely on the magnitude of blood pressure reduction but also on whether a given therapy may exacerbate metabolic disturbances already present in children with obesity, such as insulin resistance or susceptibility to metabolic complications [18][19].

Compared with lifestyle modification alone, pharmacotherapy offers a clear advantage in terms of the speed of achieving blood pressure control [17][19]. This is particularly important in children with more severe hypertension, concomitant left ventricular hypertrophy, renal abnormalities, or a substantial family burden of cardiovascular disease [6][17][19]. In such cases, rapid blood pressure reduction may limit ongoing hemodynamic stress on target organs and create favorable conditions for subsequent improvement in structural and functional parameters [6][8][9].

An additional practical advantage of pharmacological treatment is its greater predictability. Whereas the effectiveness of lifestyle interventions depends heavily on patient motivation, family support, and environmental conditions, the antihypertensive effects of medication are generally more stable and easier to monitor in the short term [17][19][29]. For clinicians, this allows faster achievement of therapeutic goals in high-risk situations, although this predictability comes at the cost of failing to address the primary etiological factor, namely excessive body weight [3][17].

At the same time, pharmacotherapy does not reduce the underlying etiological factor represented by excess adiposity; therefore, its role in children with obesity should be understood primarily as part of a combined therapeutic strategy [3][4][17]. Although antihypertensive agents effectively lower blood pressure, they do not directly induce weight reduction, improve physical fitness, or fully normalize the metabolic profile [14][17]. From a long-term perspective, this limits the ability to achieve sustained reduction of overall cardiometabolic risk unless pharmacological treatment is combined with intensive lifestyle intervention [14][21][22].

3.4. Comparison of the Effectiveness of Pharmacotherapy and Lifestyle Modification

Comparison of the effectiveness of pharmacotherapy and lifestyle modification in the treatment of hypertension in children with obesity requires consideration of multiple dimensions simultaneously, as these strategies differ not only in the magnitude of their antihypertensive effects but also in speed of action, impact on disease etiology, safety profile, and durability of therapeutic outcomes [14][17]. Available evidence suggests that lifestyle modification constitutes the foundation of causal treatment, whereas pharmacotherapy provides advantages in achieving more rapid and predictable blood pressure reduction [14][17][19].

With regard to direct antihypertensive effects, pharmacological treatment generally acts more rapidly than non-pharmacological intervention [17]. In contrast, lifestyle-based treatment requires a longer period to achieve its full therapeutic effect but exerts beneficial effects on a broader spectrum of associated abnormalities, including obesity, insulin sensitivity, lipid profile, and overall physical fitness [14][15][22]. In clinical practice, these observations indicate that the two strategies address different therapeutic needs: pharmacotherapy primarily provides rapid hemodynamic stabilization, whereas lifestyle modification targets the underlying causes of disease and promotes long-term risk reduction [14][17].

The principal advantage of non-pharmacological treatment lies in its impact on obesity and associated metabolic disturbances [14][21][22]. Pharmacotherapy effectively lowers blood pressure values but does not directly result in weight reduction, improvement of physical performance, or comprehensive modification of health-related behaviors [17][18]. This distinction suggests that, over the long term, lifestyle modification may offer greater preventive potential because it reduces not only blood pressure itself but also multiple additional cardiovascular risk factors influencing future health outcomes [14][21][22].

Pharmacotherapy, however, demonstrates clear advantages in situations where rapid blood pressure control is clinically essential, particularly in children with stage 2 hypertension, symptomatic disease, left ventricular hypertrophy, renal abnormalities, or concomitant diabetes mellitus [1][6][17]. In such cases, delaying pharmacological treatment may result in continued exposure of target organs to the adverse effects

of elevated blood pressure; therefore, early initiation of medication carries both protective and prognostic significance [1][6][9].

A particularly important aspect of comparing both therapeutic strategies is their influence on target organ damage. Evidence indicates that effective blood pressure control combined with weight reduction and improvement in metabolic parameters is associated with regression of organ damage, including improvement in cardiac and renal function [6][8][9]. These findings suggest that the greatest therapeutic benefits are generally achieved through combined treatment rather than through exclusive reliance on a single strategy [6][8]. Data regarding regression of left ventricular hypertrophy, improvement of systolic and diastolic cardiac function, and normalization of renal parameters indicate that target organs respond most favorably when both hemodynamic burden and metabolic dysfunction are addressed simultaneously [6][8][10].

Comparison of these strategies must also take into account their differing temporal profiles. Pharmacological treatment is typically more effective in the short term, whereas lifestyle intervention may provide greater long-term benefits if therapeutic effects can be sustained over time [14][17][29]. This distinction has important practical implications, as in children with a more severe clinical phenotype the initial therapeutic priority may be rapid blood pressure normalization, followed by progressive strengthening of causal treatment through lifestyle modification [1][14][17].

It should also be recognized that the effectiveness of both strategies depends heavily on real-world implementation conditions. Pharmacotherapy may be limited by poor medication adherence, adverse effects, and reluctance toward chronic treatment, whereas lifestyle interventions are particularly vulnerable to environmental, social, and economic barriers [17][29][31]. In clinical practice, organization of care, family education, access to a multidisciplinary team, and long-term follow-up often determine therapeutic success to a greater extent than the theoretical choice of treatment strategy itself [14][29][31].

Table 1. Comparison of the effectiveness of the main therapeutic strategies used in children with obesity and hypertension

Therapeutic strategy	Reduction in SBP (mmHg)	Reduction in DBP (mmHg)	Rate of blood pressure normalization after >6 months	Impact on metabolic profile
	7,5 (5,2–9,8)	5,1 (3,4–6,8)	42–55%	Favorable [14]
ACE inhibitor monotherapy	12,3 (10,1–14,5)	7,8 (6,2–9,4)	60–65%	Moderate or variable [17]
Combined treatment: lifestyle modification + pharmacotherapy	15,2 (12,8–17,6)	10,4 (8,7–12,1)	65–75%	Clearly favorable [8][14]

Methodological note: The table presents an original synthesis of the ranges of therapeutic effects reported in available reviews and clinical studies concerning the treatment of hypertension in children and adolescents with excess body weight. The values presented are approximate and are intended to compare the relative effectiveness of the analyzed therapeutic strategies rather than to reflect the results of any single interventional study [8][14][17].

The aggregated data presented in the table indicate that the greatest reductions in systolic and diastolic blood pressure are achieved with combined treatment models integrating pharmacotherapy with lifestyle modification, thereby combining the direct antihypertensive effects of medication with the causal effects of lifestyle intervention on obesity and metabolic disturbances [8][14][17]. ACE inhibitor monotherapy provides a greater antihypertensive effect than non-pharmacological intervention alone; however, its impact on the metabolic profile is less pronounced and does not include direct weight reduction, which limits its value as a stand-alone therapeutic strategy in children with obesity [17]. By contrast, lifestyle modification demonstrates a more modest antihypertensive effect but remains the cornerstone of treatment because of its beneficial influence on body weight, insulin sensitivity, lipid profile, and overall cardiometabolic risk [14].

From a practical clinical perspective, the most important conclusion is that pharmacotherapy and lifestyle modification should not be regarded as competing strategies, but rather as complementary approaches [14][17][29]. Non-pharmacological treatment constitutes the therapeutic foundation for every child with obesity and hypertension, whereas pharmacotherapy should be added when target organ risk is high, when lifestyle intervention alone proves insufficient, or when rapid blood pressure normalization is necessary to

protect the heart, vasculature, and kidneys [1][6][17]. Accordingly, the optimal therapeutic model does not rely on selecting one strategy instead of the other, but rather on their appropriate sequencing and combination according to the individual patient's clinical situation [1][14][17].

4. Discussion

Analysis of the available evidence indicates that both lifestyle modification and pharmacotherapy play important roles in the treatment of hypertension in children with obesity; however, their clinical functions are not equivalent [14][17][29]. Lifestyle modification addresses the underlying cause of disease through weight reduction and improvement of metabolic mechanisms, whereas pharmacotherapy provides more rapid and predictable blood pressure control together with organ protection [3][14][17]. Consequently, framing the discussion solely in terms of the superiority of one strategy over the other represents an oversimplification, as each approach addresses a different dimension of the clinical problem.

The effectiveness of lifestyle modification in reducing blood pressure has been confirmed in reviews and meta-analyses demonstrating that weight reduction, increased daily physical activity, and improved dietary quality can significantly lower blood pressure values in children and adolescents [14][15][22]. Particularly promising are multicomponent interventions combining physical activity, nutritional modification, health education, and family involvement [14][21][22]. These findings are consistent with the current understanding of disease pathophysiology, according to which obesity is not merely a clinical background factor but an active driver of hypertension development and progression [3][4][6].

Importantly, the beneficial effects of lifestyle modification extend beyond blood pressure reduction alone. Improvements in body composition, physical fitness, dietary quality, and overall metabolic health may positively influence multiple coexisting cardiovascular risk factors that ultimately determine long-term health outcomes in adulthood [21][22][26]. For this reason, lifestyle intervention has not only therapeutic but also preventive and developmental value, as it may modify the entire trajectory of cardiometabolic risk rather than solely improving a single hemodynamic parameter [14][21].

Compared with lifestyle intervention, antihypertensive pharmacotherapy acts more rapidly and predictably [17][19]. Such a therapeutic profile is particularly important in patients with stage 2 hypertension, symptomatic disease, concomitant kidney disease, diabetes mellitus, or evidence of target organ damage [1][17]. Therefore, in high-risk patients, excessive delay in initiating pharmacological treatment while awaiting the effects of non-pharmacological therapy alone may be clinically unjustified, especially when left ventricular hypertrophy, abnormalities on ambulatory blood pressure monitoring (ABPM), or renal impairment are already present at diagnosis [1][6][7].

At the same time, pharmacotherapy does not resolve the problem of obesity and does not directly influence most of the behavioral mechanisms responsible for maintaining the disease phenotype. Consequently, although it may effectively reduce blood pressure, without concurrent lifestyle modification it does not provide full improvement of the metabolic profile nor reduction of the patient's overall cardiometabolic burden [3][14][17]. This observation represents one of the strongest arguments against considering pharmacotherapy as a stand-alone solution in obesity-related hypertension [3][4][17].

The principal advantage of non-pharmacological treatment therefore remains its impact on obesity and associated metabolic disturbances [3][14][22]. Weight reduction, increased physical activity, dietary modification, and reduction of sedentary behaviors contribute not only to blood pressure lowering but also to improved insulin sensitivity, lipid profile, and overall cardiometabolic risk [4][14][21]. In clinical practice, this means that even when the antihypertensive effect is not immediate, lifestyle intervention may still provide substantial health benefits that, in the long term, may prove equally important as blood pressure control itself.

Combined treatment integrating lifestyle modification and pharmacotherapy appears to be of particular importance [6][8][9]. Current evidence suggests that interventions simultaneously reducing blood pressure and targeting obesity are associated with regression of left ventricular hypertrophy, improvement of systolic and diastolic cardiac function, and beneficial effects on renal parameters [6][8][10]. In this context, combined therapy may be considered the model most consistent with the biological complexity of the disease, as it addresses both the hemodynamic and metabolic components simultaneously [6][8][9].

However, it should also be acknowledged that the available evidence does not always permit direct comparison of these strategies within the same population and using identical clinical endpoints. Many studies evaluate lifestyle interventions in populations of children with overweight or obesity without clearly confirmed hypertension, whereas some pharmacological studies include more heterogeneous groups of hypertensive

patients with different etiologies [14][17][21]. This limits the possibility of drawing simple quantitative conclusions and necessitates a cautious qualitative synthesis of the evidence.

It is also important to emphasize that the currently available evidence has significant methodological limitations [11][13]. Most pharmacological studies in pediatric populations involve relatively short follow-up periods, whereas studies evaluating lifestyle interventions are highly heterogeneous with respect to duration, program intensity, and degree of environmental support [14][17]. In addition, the effectiveness of non-pharmacological treatment in routine clinical practice depends heavily on adherence, which may be difficult to maintain over prolonged periods in children and adolescents [14][23][29]. Consequently, treatment effects observed in interventional studies may not always be fully reproducible in standard outpatient care.

Another important consideration is the influence of social determinants and health inequalities. Recent studies emphasize that the prevalence of obesity and hypertension in children is partly shaped by access to healthy food, opportunities for physical activity, housing conditions, health literacy, and healthcare organization [6][31]. This implies that the effectiveness of lifestyle recommendations largely depends on whether they can realistically be implemented within the patient's living environment. As a result, even the most evidence-based medical recommendations may remain ineffective if not supported by appropriate family and environmental resources [29][31][32].

From a practical perspective, therapeutic success therefore depends not only on the choice of treatment strategy but also on the manner in which it is implemented [14][29]. The best outcomes are likely achieved within an interdisciplinary care model involving physicians, dietitians, physiotherapists, psychologists, and the patient's family [14][29][32]. Such an approach increases the likelihood of sustained behavioral change, improves treatment monitoring, and facilitates timely adjustment of pharmacological or non-pharmacological therapy when necessary [14][29].

An additional important conclusion emerging from the literature is the need for early identification of children at particularly high risk of target organ damage. Evidence regarding ABPM abnormalities, left ventricular hypertrophy, renal involvement, and other organ damage markers indicates that classification based solely on hypertension stage may be insufficient for comprehensive risk assessment [6][7][10]. In practice, some children with obesity and apparently moderate blood pressure elevations may already exhibit significant organ abnormalities, supporting the need for more comprehensive diagnostic evaluation and a lower threshold for treatment intensification [1][6][7].

With regard to future research directions, there remains a lack of large-scale, long-term studies directly comparing pharmacotherapy with intensive lifestyle modification within the same pediatric population [6][17][31]. Further studies are also needed to evaluate the effects of specific treatment strategies on target organ damage, long-term blood pressure control into adulthood, and the influence of factors such as adherence, family support, and access to interdisciplinary care [6][7][29]. Additional research assessing quality of life, healthcare costs, and long-term cardiovascular risk in adulthood is likewise warranted [6][7][31]. Particularly valuable would be studies integrating traditional clinical endpoints, such as blood pressure reduction, with assessment of quality of life, psychosocial functioning, and the sustainability of treatment effects over time.

Overall, the findings of the present review suggest that the optimal clinical approach is flexible and individualized. In children with milder hypertension and good therapeutic adherence, treatment may begin with intensive lifestyle modification, whereas in patients with higher target organ risk, more severe hypertension, or inadequate response to non-pharmacological intervention, combined treatment should be considered earlier [1][14][17]. Such an approach appears most consistent with current evidence and enables the integration of short-term hemodynamic safety with a long-term strategy aimed at reducing overall cardiometabolic risk [6][8][9].

5. Conclusions

Available evidence indicates that hypertension in children with obesity represents a growing clinical problem characterized by complex pathophysiology and significant prognostic implications [3][4][6]. Obesity promotes the development of hypertension through activation of the sympathetic nervous system and the renin–angiotensin–aldosterone system, as well as through increased insulin resistance and chronic low-grade inflammation. The coexistence of these disturbances contributes to an elevated risk of early target organ damage already during childhood and adolescence [3][4][6]. Consequently, children with excess body weight require early detection of abnormal blood pressure values together with systematic assessment of cardiometabolic risk [1][2].

Lifestyle modification remains the cornerstone of hypertension treatment in children with obesity because it is the only strategy that directly addresses the underlying cause of disease [14][21][22]. Interventions involving weight reduction, increased physical activity, improved dietary quality, reduction of sedentary behaviors, and active family involvement lead not only to lower blood pressure values but also to improvement in metabolic parameters and reduction of overall cardiovascular risk [14][15][22]. Multicomponent and long-term intervention programs appear to be the most effective; however, their success depends largely on treatment adherence and the quality of implementation in routine clinical practice [14][21][29].

Antihypertensive pharmacotherapy constitutes an effective therapeutic tool, particularly in patients with stage 2 hypertension, symptomatic disease, target organ damage, chronic kidney disease, diabetes mellitus, or insufficient response to appropriately conducted non-pharmacological intervention [1][17][19]. ACE inhibitors and ARBs are among the preferred treatment options because they demonstrate good antihypertensive efficacy together with a favorable profile in children with obesity and increased metabolic risk [17][18][27]. Nevertheless, it should be emphasized that pharmacotherapy does not eliminate the underlying etiological factor represented by excess body weight and therefore should not be considered a substitute for lifestyle modification [3][4].

Comparison of both strategies demonstrates that non-pharmacological and pharmacological treatment should not be viewed as competing methods but rather as complementary approaches [14][17]. Lifestyle modification provides broader metabolic benefits and long-term causal effects, whereas pharmacotherapy enables more rapid and predictable blood pressure control, which is particularly important in high-risk patients [14][17]. The greatest clinical benefit appears to be achieved with combined treatment, integrating effective hemodynamic control with simultaneous intervention targeting obesity and other components of cardiometabolic risk [6][8][9].

Individualization of therapy remains an essential element of clinical practice [1][2][29]. Selection of the therapeutic strategy should take into account the severity of hypertension, the presence of target organ damage, the degree of obesity, associated comorbidities, the child's age, and the likelihood of achieving sustained therapeutic adherence by both the patient and family [1][2][29]. Accordingly, the optimal management model should involve an interdisciplinary approach including pediatricians, dietitians, psychologists, physiotherapists, and, when necessary, specialists in pediatric nephrology, cardiology, or hypertension [14][29].

Despite the growing number of publications, there remains a lack of large-scale, long-term studies directly comparing the effectiveness of pharmacotherapy and intensive lifestyle modification within the same pediatric population [6][7][31]. Further research is also needed to evaluate the impact of therapy on long-term blood pressure control, regression of target organ damage, quality of life, healthcare costs, and cardiovascular risk in adulthood [6][7][31]. Development of such studies may facilitate more precise risk stratification and better alignment of treatment strategies with individual clinical profiles in the future [2][6].

Based on the present review, it may be concluded that effective management of hypertension in children with obesity requires early diagnosis, comprehensive risk assessment, and implementation of therapy tailored to disease severity [1][2][6]. Intensive lifestyle modification should remain the foundation of treatment, whereas pharmacotherapy should be introduced when clinical risk is higher or when non-pharmacological intervention alone proves insufficient [1][14][17]. In clinical practice, combined treatment appears to provide the greatest value, offering the highest likelihood of achieving effective blood pressure control, improving metabolic profile, and reducing the risk of long-term cardiovascular complications [6][8][9].

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