REVIEW ARTICLE

Juvenile Idiopathic Arthritis and Secondary Cardiometabolic Risk in Paediatric Populations

Sharmila Thirumalaikumar[1,2*], Ashiba Marikar[3,*]

[1] School of Health and Life Sciences, Teesside University, United Kingdom

[2] School of Health Sciences, Management Development Institute of Singapore, Republic of Singapore

[3] Institute of Public Health, College of Medicine and Health Sciences, United Arab Emirates University, 15551, Al Ain, Abu Dhabi, UAE

***Corresponding Author:** Sharmila Thirumalaikumar, Ashiba Marikar
[1] School of Health and Life Sciences, Teesside University, United Kingdom.
[2] School of Health Sciences, Management Development Institute of Singapore, Republic of Singapore
[3] Institute of Public Health, College of Medicine and Health Sciences, United Arab Emirates University, 15551, Al Ain, Abu Dhabi, UAE.
Email: sharmilakumar1234@gmail.com; ashibanaushadm@gmail.com

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Abstract

Juvenile idiopathic arthritis is the most common chronic inflammatory rheumatic disease of childhood. It is traditionally considered a joint-limited disorder. Recent evidence shows that juvenile idiopathic arthritis is a systemic inflammatory condition. Persistent inflammation affects metabolic and cardiovascular health from an early age. Children with juvenile idiopathic arthritis are at increased risk of developing secondary cardiometabolic abnormalities. Chronic inflammation in juvenile idiopathic arthritis is associated with elevated levels of pro-inflammatory cytokines. These cytokines disrupt insulin signalling and lipid metabolism. Altered adipokine secretion contributes to insulin resistance and dyslipidaemia. Endothelial dysfunction and early vascular changes such as increased carotid intima-media thickness have been reported in affected children. Oxidative stress further worsens metabolic imbalance and vascular injury. Antirheumatic therapies influence cardiometabolic risk in different ways. Effective disease control using conventional disease-modifying antirheumatic drugs and biologic agents can reduce inflammation-driven metabolic complications. In contrast prolonged glucocorticoid exposure is associated with weight gain hypertension impaired glucose tolerance and adverse lipid profiles. These effects are particularly concerning in paediatric populations due to long treatment duration. Reduced physical activity is common in children with juvenile idiopathic arthritis due to pain stiffness and fatigue. This leads to unfavourable body composition with increased fat mass and reduced muscle mass. Lifestyle factors including poor diet limited exercise and psychosocial stress further increase cardiometabolic risk. This review summarises the pathophysiological mechanisms linking juvenile idiopathic arthritis with secondary cardiometabolic risk. It also highlights the impact of treatment and lifestyle factors. Early screening optimal inflammation control and multidisciplinary preventive strategies are essential to improve long-term cardiovascular and metabolic outcomes in children with juvenile idiopathic arthritis.

1. Introduction

Juvenile idiopathic arthritis represents the most common chronic inflammatory rheumatic disease in paediatric and adolescent populations. It is characterised by persistent arthritis lasting for at least six weeks. The disease begins before the age of sixteen years. The aetiology of juvenile idiopathic arthritis remains unknown. It was previously considered a condition that mainly affects the musculoskeletal system. Current understanding recognises juvenile idiopathic arthritis as a systemic inflammatory disease. Its effects extend beyond joint involvement and cause long-term health consequences. Children with chronic inflammatory conditions such as juvenile idiopathic arthritis have an increased risk of secondary cardiometabolic complications. This increased risk is largely due to prolonged systemic inflammation. Chronic inflammation negatively

affects vascular metabolic and endocrine pathways from early stages of development (Kavey et al., 2006). Despite advances in treatment including the widespread use of biologic agents and treat-to-target strategies individuals with juvenile idiopathic arthritis continue to show a higher risk of developing cardiovascular disease in adulthood (Aranda-Valera et al., 2020).

Evidence from adult inflammatory arthritis helps explain this association. In adults with rheumatoid arthritis cardiovascular disease is a major cause of morbidity and mortality. Ischaemic heart disease occurs more frequently than in the general population (Boman et al., 2022; Sparks et al., 2016). Chronic systemic inflammation accelerates atherosclerosis and promotes vascular injury. This establishes a clear relationship between inflammatory disease activity and adverse cardiovascular outcomes (Sattar et al., 2003). Approximately forty percent of individuals diagnosed with juvenile idiopathic arthritis during childhood experience persistent disease into adulthood. This leads to prolonged exposure to inflammatory mediators. As a result cumulative cardiometabolic risk increases over time (Selvaag et al., 2016). These findings highlight the importance of early identification and effective management of cardiovascular and metabolic risk factors in children with juvenile idiopathic arthritis.

2. Juvenile Idiopathic Arthritis in Paediatric Populations

The origins of cardiovascular disease can begin during childhood. Early exposure to behavioural and biological risk factors strongly influences long-term cardiovascular health. Optimal cardiovascular health in children is defined by specific healthy behaviours and clinical indicators. Healthy behaviours include no exposure to second-hand tobacco smoke. A body mass index below the eighty-fifth percentile is also important. Children should engage in at least sixty minutes of physical activity each day. A healthy and balanced diet is essential for maintaining cardiovascular health. Ideal health indicators include normal blood pressure. Normal total cholesterol levels are required. Normal fasting blood glucose levels are also necessary (Steinberger et al., 2016). Clinical cardiovascular events are rare during childhood. However, many children and adolescents are exposed to risk factors that increase the likelihood of cardiovascular disease in adulthood. These risk factors may persist silently for many years before clinical symptoms appear (Bouhanick et al., 2021; EXPERT PANEL ON INTEGRATED GUIDELINES FOR CARDIOVASCULAR HEALTH AND RISK REDUCTION IN CHILDREN AND ADOLESCENTS, 2011). In paediatric patients with juvenile idiopathic arthritis traditional cardiovascular risk factors are often present. These risk factors coexist with disease-specific factors. Chronic systemic inflammation plays a major role. Altered body composition contributes to metabolic imbalance. Reduced physical activity is common due to pain and functional limitation. Metabolic side effects related to long-term treatment further increase risk (Figure 1).

3. Pathophysiological Links Between Juvenile Idiopathic Arthritis and Cardiometabolic Risk

The link between juvenile idiopathic arthritis and cardiometabolic risk is increasingly recognised. This association is mainly driven by long-term systemic inflammation. Inflammation interacts with metabolic and vascular pathways during critical periods of growth and development. The cardiovascular disease is rare in children. However growing evidence shows that children and adolescents with juvenile idiopathic arthritis develop early subclinical abnormalities. These changes may increase the risk of cardiometabolic disorders later in life. These physiological alterations arise from several interacting mechanisms. Chronic immune activation plays a central role. Endothelial dysfunction contributes to early vascular changes. Metabolic dysregulation further worsens cardiometabolic balance. Shared genetic predisposition may also influence disease progression and risk. Together these factors explain why juvenile idiopathic arthritis is associated with increased long-term cardiometabolic vulnerability. Early identification of these changes is important for preventing future cardiovascular and metabolic complications.

3.1. Chronic Inflammation and Endothelial Dysfunction

Sustained immune activation is a key feature of juvenile idiopathic arthritis. This immune activation can persist even in patients who achieve clinical remission. Pro-inflammatory cytokines such as tumor necrosis factor-α interleukin-1β and interleukin-6 play an important role in disease progression (Aranda-Valera et al., 2020; Sattar et al., 2003). These cytokines directly affect vascular endothelial cells. They promote endothelial activation

and increase oxidative stress. They also reduce nitric oxide availability. This leads to impaired vasodilation and vascular dysfunction. Endothelial dysfunction is considered an early and potentially reversible stage of atherosclerosis. It represents a critical link between chronic inflammatory diseases and long-term cardiovascular risk. Studies evaluating carotid intima–media thickness as a marker of early atherosclerosis have shown variable findings in paediatric juvenile idiopathic arthritis populations. Some studies report increased carotid intima–media thickness in children with active disease. Other studies report values similar to healthy controls. These findings are more common in patients with low disease activity or sustained remission (Breda et al., 2013; Del Giudice et al., 2018). Importantly vascular involvement may occur even without visible structural changes. Elevated circulating biomarkers of endothelial activation have been consistently reported. These include vascular endothelial growth factor A intercellular adhesion molecule-1 and E-selectin. Their presence suggests that endothelial dysfunction may precede detectable anatomical alterations (Aranda-Valera et al., 2020). Longitudinal studies in young adults with a history of juvenile idiopathic arthritis demonstrate persistent subclinical inflammation. Endothelial dysfunction may remain despite long periods of clinical remission. These findings highlight the possibility of enduring cardiovascular vulnerability that begins in childhood (Aranda-Valera et al., 2020).

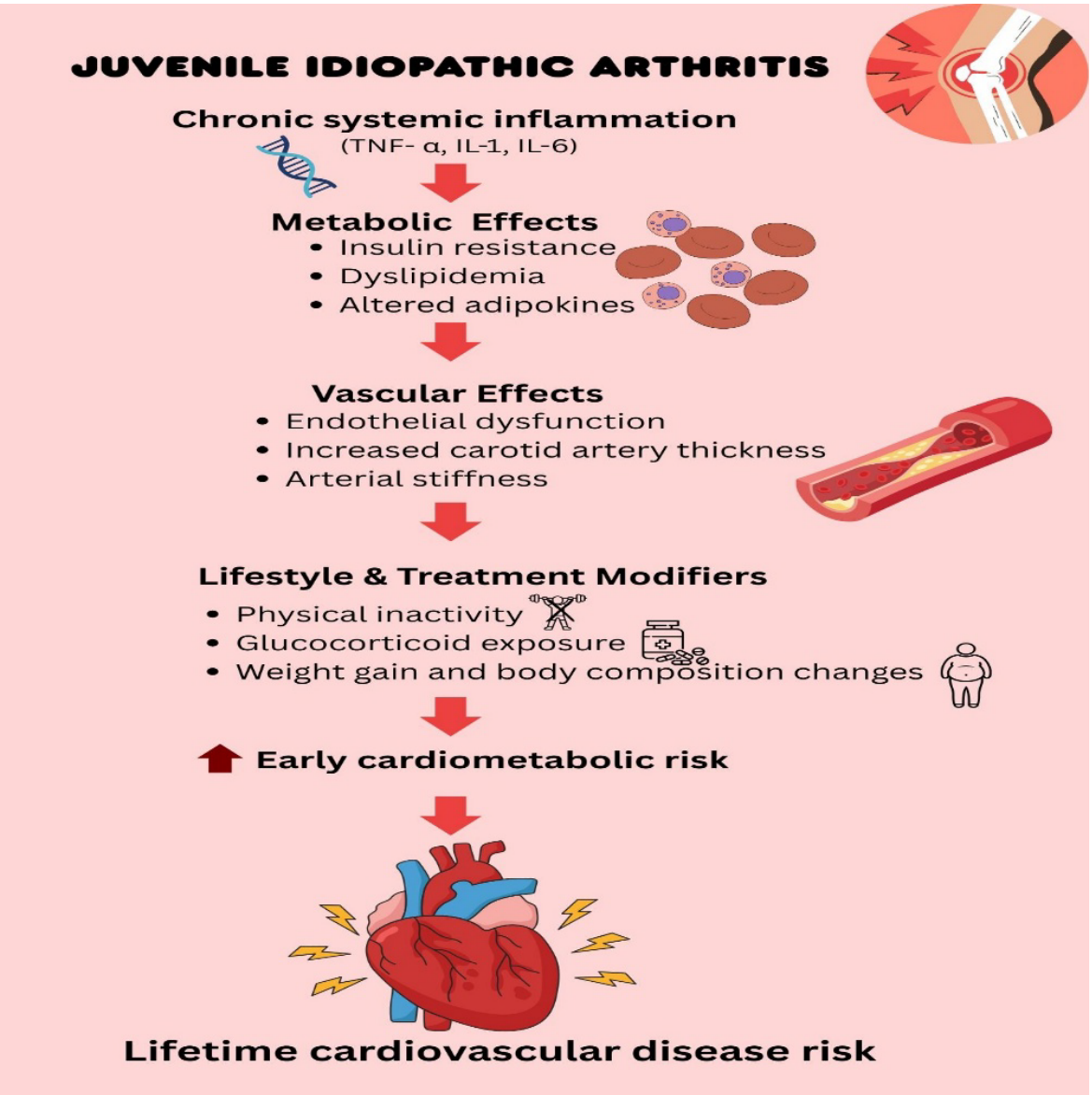

Figure 1: Juvenile Idiopathic Arthritis and Cardiometabolic risk

3.2. Metabolic Dysregulation and Adipokine Imbalance

Adipose tissue is now recognised as an active endocrine organ. It influences inflammation insulin sensitivity and lipid metabolism. These effects occur through the release of adipokines. In juvenile idiopathic arthritis dysregulation of adipokine profiles has been reported. Elevated levels of resistin and visfatin have been observed. Both adipokines show pro-inflammatory and pro-atherogenic properties (Aranda-Valera et al., 2020). These changes may worsen systemic inflammation. They may also increase cardiometabolic risk independent of body mass index. Abnormal lipid profiles have been documented in children and young adults with juvenile idiopathic arthritis. Increased total cholesterol levels are commonly reported. Altered apolipoprotein ratios have also been observed. These changes can occur even during periods of disease quiescence (Coulson et al., 2013) . Such findings support the concept of inflammation-driven dyslipidaemia. This pattern is similar to that seen in adult rheumatoid arthritis. Insulin resistance has been identified in certain subgroups of patients with juvenile idiopathic arthritis. This condition may be mediated by cytokine activity. Adipokine-induced disruption of insulin signalling pathways also plays a role. These mechanisms further strengthen the link between chronic inflammation and metabolic dysfunction in juvenile idiopathic arthritis (Clark et al., 2019) .

3.3. Genetic and Molecular Mechanisms Linking JIA to Cardiometabolic Risk

Emerging genetic and molecular evidence further supports the association between juvenile idiopathic arthritis and cardiometabolic risk. Recent studies using polygenic risk scores show that genetic susceptibility to juvenile idiopathic arthritis is linked to adverse cardiometabolic traits. These traits include elevated diastolic blood pressure. Increased insulin resistance has also been reported. Higher levels of systemic inflammatory markers are commonly observed. Greater adiposity is present from early childhood through young adulthood. These findings suggest the presence of shared genetic mechanisms. These mechanisms regulate immune dysfunction vascular inflammation and metabolic homeostasis. Genetic susceptibility appears to interact with chronic inflammation. This interaction promotes early vascular and metabolic disturbances. As a result long-term cardiometabolic risk increases in individuals with juvenile idiopathic arthritis (Zaripova et al., 2021).

In addition to disease-related inflammation genetic factors play an important role in cardiometabolic risk. Polygenic risk analyses indicate that genetic vulnerability to juvenile idiopathic arthritis is associated with unfavourable cardiometabolic characteristics. These include increased diastolic blood pressure insulin resistance systemic inflammation and adiposity. These patterns persist across different stages of life. Several immune-related genes involved in the pathogenesis of juvenile idiopathic arthritis have also been linked to cardiometabolic abnormalities. Genes involved in cytokine signalling contribute to endothelial dysfunction. Genes related to innate immune regulation influence metabolic imbalance (Hersh and Prahalad, 2015). This shared genetic background may promote persistent low-grade inflammation. Over time this increases vascular and metabolic vulnerability. Overall, these findings support the concept that cardiometabolic risk in juvenile idiopathic arthritis arises from the combined effects of genetic predisposition and chronic inflammatory exposure. This process begins early in life and continues into adulthood (Lee et al., 2020; Zaripova et al., 2021).

4. Influence of Antirheumatic Therapy on Cardiometabolic Health

Juvenile idiopathic arthritis is a chronic inflammatory disease. It is characterised by persistent synovitis and systemic immune activation. Multiple immune cells are involved in disease progression. These include dendritic cells macrophages T lymphocytes B lymphocytes neutrophils fibroblasts and osteoclasts (Zaripova et al., 2021) . In addition to joint damage prolonged inflammation in juvenile idiopathic arthritis contributes to secondary cardiometabolic risk. Several mechanisms are involved in this process. Endothelial dysfunction plays a key role. Dyslipidaemia is commonly observed. Insulin resistance contributes to metabolic imbalance. Vascular remodelling further increases cardiovascular risk. These mechanisms are similar to those seen in adult rheumatoid arthritis (Ravelli and Martini, 2007; Sattar et al., 2003). Antirheumatic therapies therefore have a dual effect on cardiometabolic health. Effective treatment reduces inflammation-driven vascular injury. However some therapies may also produce adverse metabolic effects. Careful selection and monitoring of treatment strategies are essential to balance these outcomes.

4.1. Non-steroidal Anti-inflammatory Drugs (NSAIDs)

Non-steroidal anti-inflammatory drugs are widely used in the treatment of juvenile idiopathic arthritis.

These drugs reduce pain and inflammation. They act by inhibiting cyclooxygenase enzymes. This inhibition decreases prostaglandin synthesis (Baoqi et al., 2021). Cyclooxygenase pathways play an important role in cardiovascular homeostasis. They regulate the balance between prostacyclin and thromboxane A_2. These mediators influence platelet aggregation and vascular tone. Disruption of this balance can have adverse cardiovascular effects. Selective cyclooxygenase-2 inhibition is particularly associated with risk. It may lead to vasoconstriction thrombosis and hypertension (Vastert et al., 2009). Evidence from studies in inflammatory arthritis shows increased cardiovascular risk with non-selective non-steroidal anti-inflammatory drugs and cyclooxygenase-2 inhibitors. Reported events include myocardial infarction and stroke. The level of risk depends on drug selectivity dosage and duration of use (Baoqi et al., 2021). Data on cardiovascular outcomes in paediatric populations are limited. However findings from adult studies suggest caution with long-term non-steroidal anti-inflammatory drug use in juvenile idiopathic arthritis. When these drugs are necessary agents with lower cyclooxygenase-2 selectivity are preferred. Ibuprofen and naproxen are commonly recommended options. This is especially important for patients with existing cardiometabolic risk factors (Baoqi et al., 2021).

Glucocorticoids are commonly used in the treatment of juvenile idiopathic arthritis. They are especially used for rapid control of severe inflammation. This is particularly important in systemic juvenile idiopathic arthritis and during acute disease flares. Glucocorticoids reduce inflammation through several mechanisms. They inhibit pro-inflammatory cytokines such as tumor necrosis factor-α interleukin-1 and interleukin-6. They suppress T helper 1 and T helper 17 immune responses. They also induce apoptosis of lymphocytes (Liu et al., 2024; Strehl et al., 2019). By reducing inflammatory burden short-term glucocorticoid therapy may temporarily lower cardiovascular risk related to inflammation. However prolonged or high-dose glucocorticoid use is strongly associated with adverse cardiometabolic effects. These include hypertension dyslipidaemia insulin resistance obesity and type 2 diabetes (Xie et al., 2020). Observational studies in inflammatory arthritis show a dose-dependent and duration-dependent increase in cardiovascular risk. Higher cumulative glucocorticoid exposure is linked to increased rates of myocardial infarction and heart failure (Davis et al., 2007). In paediatric populations these risks are of particular concern. Children may be exposed to glucocorticoids for long periods during growth and development. Therefore current treatment strategies emphasise the use of the lowest effective dose. Therapy should be limited to the shortest possible duration. Regular monitoring of blood pressure lipid levels and glucose metabolism is strongly recommended (Avina-Zubieta et al., 2013; Costello et al., 2021).

4.2. Conventional Disease-Modifying Antirheumatic Drugs

Methotrexate (MTX) serves as the foundational agent in the therapeutic regimen for JIA, exerting anti-inflammatory effects through the inhibition of folate metabolism, the enhancement of adenosine release, and the suppression of IL-1β-mediated inflammatory signaling (Romano et al., 2018). Empirical evidence from rheumatoid arthritis consistently indicates that the utilization of MTX is linked with a reduction in cardiovascular morbidity and mortality, primarily due to its effective suppression of systemic inflammation (Westlake et al., 2010). It is plausible that analogous cardioprotective mechanisms are operative in the context of JIA. MTX administration has been correlated with improved endothelial function and a reduction in carotid intima-media thickness, suggesting a protective effect against the development of atherosclerosis (Landewe et al., 2000). However, MTX has the potential to elevate homocysteine levels, a recognized cardiovascular risk factor, thereby underscoring the necessity for folic acid supplementation during the course of treatment (Widdifield et al., 2019). Overall, when employed early and judiciously, MTX is regarded as conferring a net cardiometabolic advantage in JIA.

Sulfasalazine (SASP) displays anti-inflammatory properties through the inhibition of leukocyte chemotaxis, NF-κB activation, and TNF-α production (Vohra et al., 2015). Evidence suggests that SASP may enhance endothelial function, lipid metabolism, and platelet activity, thereby exerting a beneficial impact on cardiovascular risk (Tam et al., 2017). No consistent associations have been documented between SASP utilization and adverse cardiovascular outcomes.

Hydroxychloroquine (HCQ) possesses immunomodulatory characteristics mediated through the disruption of lysosomal activity, antigen presentation, and autophagy, leading to a decreased production of pro-inflammatory cytokines such as IL-1, IL-6, and TNF-α (Lotteau et al., 1990). HCQ has been associated with enhanced insulin sensitivity, reduced glucose levels, and favourable lipid profiles, which collectively contribute to a diminished cardiovascular risk in individuals with inflammatory arthritis (Sharma et al., 2016). Although rare instances of cardiotoxicity, including conduction abnormalities, have been reported with prolonged HCQ administration, such occurrences are infrequent, and

routine clinical surveillance is generally adequate (Landewe et al., 2000; Sharma et al., 2016). Overall, antirheumatic treatment has diverse cardiometabolic health impacts in JIA. Cardiovascular risk is likely to be reduced by the presence of effective suppression of systemic inflammation, especially with early and continued use of MTX and other DMARDs. Conversely, chronic effects of glucocorticoids and some NSAIDs are likely to worsen metabolic and vascular issues. The observations indicate the significance of steroid-sparing interventions, early treat-to-target interventions, and regular cardiometabolic risk monitoring as inseparable constituents of long-term JIA treatment (Baoqi et al., 2021).

5. Body Composition, Physical Exercise, and Lifestyle Factors

A change in body composition, poor physical activity, and unhealthy lifestyle behaviours are progressively identified as the relevant factors in cardiometabolic risk among children and adolescents with juvenile idiopathic arthritis (JIA) (Bohr et al., 2015a). These determinants often combine with disease activity and exposure to treatment, increasing metabolic susceptibility to levels even higher than those found in the general paediatric population, and leading to the development of cardiovascular risks throughout life (Steinberger et al., 2009). Adiposity and Body Composition. JIA children usually have distorted body composition that cannot be accurately described using body mass index (BMI). Many of these studies have shown an increment in total, central fat mass, a decrease in lean muscle mass, and a shift in fat distribution in paediatric JIA patients even with BMI levels that fall within the normal range (Coulson et al., 2013; Guzman et al., 2017). These alterations are believed to be as a consequence of a mixture of chronic systemic inflammation, decreased physical activity because of pain and fatigue, and metabolic impacts of glucocorticoid treatment(Zaripova et al., 2021). Oversaturation of adiposity is particularly relevant in JIA because adipose tissue is an active endocrine organ that secretes obese pro-inflammatory adipokines, and thus maintains low-grade inflammation of the system. Higher fat mass indices have also been linked to higher inflammatory markers and unhealthy lipid profiles in children with JIA, indicating a two-way relationship between inflammatory and metabolic dysfunction (Kawai et al., 2021) . Interestingly, even low disease activity or clinical remission patients have been found to be increasingly adipose, and this implies that cardiometabolic risk might not be eliminated despite the absence of evident inflammatory load.

6. Physical Exercise and Sedentary Behaviour

The problem of insufficient physical activity among paediatric patients with JIA is well-reported. Participation in regular exercise is frequently inhibited by joint aches, stiffness, fatigue and fears of the symptoms worsening and this results in more sedentary behaviour (Bos et al., 2016). Accelerometry-based objective measurements have demonstrated that a high proportion of children with JIA is not complying with recommended daily physical activity, and that they are experiencing much less moderate-vigorous physical activity than healthy children (Gruca et al., 2023). Less exercise activity leads to poor cardiometabolic phenotypes through induction of weight gain, insulin resistance and reduced cardiorespiratory fitness. Within the framework of JIA, physical inactivity can contribute to the further worsening of muscle degradation, deconditioning and functional disability, inducing a vicious circle of decreased physical ability and the growing metabolic risk (Björk et al., 2022). Notably, the positive changes in the disease activity do not always result in the rise in the level of physical activity, which explains the necessity of specific, structured interventions, which would facilitate the safe and sustainable physical exercises among this group of people (Lavallée et al., 2019).

6.1. Dietary Patterns and Lifestyle Factors

Food habits and more general lifestyle determinants can also have an impact on cardiometabolic outcomes in JIA children, but this field is still relatively under researched. According to the emerging evidence, the quality of the diet among this population is not always the best with the insufficient consumption of fruit, vegetables and whole grains being reported in some cohorts (Mozaffarian, 2016a). Lack of compliance to cardioprotective dietary habits can exacerbate inflammatory-mediated metabolic imbalances and lead to the development of dyslipidaemia and insulin resistance (Romeo et al., 2012). A recent assessment of cardiovascular health indicators in children with JIA has also found that only one respondent had ideal cardiovascular health as assessed through a composite of behavioural and biological risk factors (Gruca et al., 2023). The identification of this result demonstrates the cumulative effects of lifestyle-related behaviours on cardiometabolic risk and the lack of opportunities to prevent it in children and adolescence (Arsenaki et al., 2020).

6.2. Interaction of Disease, Lifestyle and Cardiometabolic Risk

The correlation between JIA, lifestyle behaviours and cardiometabolic risk is multi-factorial and complex. Chronic inflammation can predispose the infected children to exhaustion, pain and lack of physical activities whereas lack of physical activities and overweight contribute to the propagation of inflammatory cascades and metabolic imbalances. This two-way communication implies that preventing cardiometabolic risks in JIA is best done through a multidisciplinary model of effective disease control coupled with encouraging physical exercise, healthy body composition, and lifestyle adjustment, starting at an earlier age (Bohr et al., 2015b).

7. Prevention and Therapeutics Strategies

The combination of the effects of chronic inflammation, exposure to treatment and lifestyle-related factors necessitates preventive and therapeutic strategies to reduce the cardiometabolic risk among children and adolescents with juvenile idiopathic arthritis (JIA) (Ringold et al., 2019a). Despite paediatric obesity posing a significant societal health problem, children with JIA can be especially susceptible to negative cardiometabolic consequences because of the effect of metabolic dysregulation on inflammation, decreased physical activity and glucocorticoid use (Gronlund et al., 2014). Notably, the metabolic and cardiovascular derangements linked to obesity and inflammation usually start at a tender age and may continue throughout the adult stage, regardless of the adult weight status, which has a profound significance in highlighting the core role of early prevention in chronic inflammatory childhood diseases like JIA (Gami et al., 2007).

The main intervention in cardiometabolic risk reduction in JIA is lifestyle-based interventions. Regular exercise and a decrease in sedentary lifestyles should be encouraged because physical inactivity is a contributing factor to the excess adiposity, insulin resistance and poor cardiovascular fitness(Ringold et al., 2019a). Pain, fatigue and functional restrictions may limit activity participation and in this case, it is necessary to have disease-adapted exercise programmes that are safe and sustainable in children with JIA. This is especially applicable to the adoption of healthy movement behaviours in childhood, since early lifestyle patterns are likely to be followed throughout adulthood and potentially affect health-related metabolic programming over the long term (Bohr et al., 2015b).

Dietary education and nutritional strategies are also significant prevention elements. In childhood, dietary quality has been associated with dyslipidaemia, insulin resistance and systemic inflammation, and all of these factors could further exacerbate the inflammatory milieu of JIA (Dalwood et al., 2020). The diet approaches emphasising the cardioprotective, nutrient-dense and balanced diet might aid in overcoming the metabolic imbalances associated with obesity as well as normal growth and development (Mozaffarian, 2016b). There are various indications that dietary change can have anti-inflammatory effects, which could mitigate obesity-associated outcomes in paediatric groups with chronic inflammatory diseases (Rodríguez-Hernández et al., 2013a).

In the management of cardiometabolic risk reduction in JIA, a key treatment goal will be optimal control of disease activity. Low-grade inflammation that occurs chronically is also a key pathway in the pathophysiology of the insulin resistance condition, dyslipidemia and vascular dysfunction, which connects inflammatory arthritis with subsequent cardiovascular disease (Santulli et al., 2025). The initial use of disease-modifying antirheumatic drugs (DMARDs), as well as a timely escalation of treatment, can decrease cumulative inflammatory pressure and indirectly enhance metabolic performance. On the other hand, one must as much as possible reduce the amount of time a child is exposed to systemic glucocorticoids since, in paediatric groups, they have long been associated with weight gain, hypertension, impaired glucose metabolism and dyslipidaemia (Lee et al., 2025).

Preventive care in JIA also includes regular screening of cardiometabolic risk factors. Biometrical body composition, blood pressure, lipid profiles and glucose metabolism can be monitored so that children at the risk can be identified early enough and timely intervention can be done (Ringold et al., 2019b). In some of the most severe obesity cases or refractory metabolic complications, it might be reasonable to refer to specialised multidisciplinary teams to consider intensified medical or behavioural interventions, but such measures should be individualised to the paediatric JIA population (Robinson and Armstrong, 2024). All in all, the cardiometabolic disease prevention in JIA needs to be conducted using an integrated, life-course approach that entails the incorporation of the combination of optimal disease control and early lifestyle intervention. Preventive strategies enacted in childhood can help to minimise the future cardiovascular and metabolic disease burden and enhance both the long-term health outcomes and quality of life of affected people with JIA (Lloyd-Jones et al., 2022) .

8. Future Projections and Research Gaps

Although there is a growing awareness of the cardiometabolic risk related to JIA, much is not known in terms of the long-term mechanisms, pathways and the most effective preventive measures. The existing evidence mostly relies on cross-sectional studies and small longitudinal cohorts, which do not provide the possibility of determining causal relationships between childhood inflammatory burden, exposure to treatment, and future cardiometabolic events (Oliveira Ramos et al., 2024). The priority of future studies should be placed on large, prospective longitudinal studies following children with JIA from diagnosis to adulthood to define the natural history of cardiometabolic risk and detection of critical periods of intervention (Pigeot and Ahrens, 2025).

These studies should be further clarified by the study of the relative roles of chronic inflammation, physical inactivity, and alterations in body composition in the pathogenesis of cardiometabolic dysfunction in JIA. Although subclinical atherosclerosis and metabolic dysregulation appear to be predictable by biomarkers, the predictive ability of the biomarkers on future cardiovascular events remains unclear (Rodríguez-Hernández et al., 2013b). Early risk stratification and tailored preventive interventions might be enhanced by the identification and validation of sensitive age-specific biomarkers that include inflammatory mediators, adipokines, endothelial activity markers and imaging based biomarkers (Pischon and Nimptsch, 2026).

The cardiometabolic impact of antirheumatic treatments in the pediatric population is also an area that needs further investigation. Even though disease-modifying antirheumatic drugs can be used indirectly to lower cardiovascular risk by better controlling inflammation, the metabolic impacts of early biologic and targeted synthetic therapeutic in childhood are yet to be fully comprehended. Comparative research that evaluates the cardiometabolic results of various treatment regimens, the cumulative effects of drugs and the time of their initiation should be conducted to enable evidence-based clinical practice (Radha Krishnan et al., 2025).

The use of lifestyle interventions is an area of potential but not well-studied in JIA. Although exercise and diet change have been demonstrated to positively influence the cardiometabolic health of the general pediatric population, a quality of JIA-specific intervention trials are lacking to assess feasibility, safety and long-term efficacy (Wan Mohd Zin et al., 2024). It is advised that future research should aim at designing and evaluating disease-specific physical activity programme, nutritional intervention and behavioural change methodologies that consider the impact of the disease, treatment and psychosocial implications (Demark-Wahnefried et al., 2015).

Another area of future study that is based on genetic and epigenetic research is significant. There is some emerging data that indicate that there are shared genetic pathways between immune dysregulation and metabolic disease, although their applicability in JIA has not been studied in detail. Lastly, one should integrate genomic, epigenomic and multi-omics solutions with clinical and lifestyle data to gain a better understanding of personal susceptibility to cardiometabolic complications in JIA and develop precision medicine solutions (Kim et al., 2024). At this moment, there is no standardized screening protocols and management strategies, which creates differences in clinical practice. Multidisciplinary teams of pediatric rheumatologists, cardiologists, endocrinologists and public health experts will be needed to transfer emerging evidence into comprehensive care models to cover both long-term cardiometabolic health and inflammatory disease control (Ardalan et al., 2022) .

9. Conclusion

Juvenile idiopathic arthritis is a systemic inflammatory disease with long-term cardiometabolic consequences. Chronic inflammation and metabolic disturbances begin early in life. These changes may persist into adulthood. Children with juvenile idiopathic arthritis are therefore at increased risk of future cardiovascular and metabolic diseases. Early disease control is essential to limit inflammatory burden. Regular screening for cardiometabolic risk factors is necessary. Lifestyle interventions should be integrated into routine care. A multidisciplinary and preventive approach can improve long-term health outcomes and quality of life in individuals with juvenile idiopathic arthritis.

Declaration

Author Contributions

S.T and A.M conceived the idea, performed the literature review, and wrote the manuscript. The author approved the final version of the manuscript.

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Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript.

Ethical Approval

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