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SCIENTIFIC FOUNDATIONS OF DESIGN AND TECHNOLOGY FOR MANUFACTURING ORTHOPEDIC FOOTWEAR FOR ADOLESCENTS

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Abstract
This article examines the scientific foundations of designing orthopedic footwear for adolescents, taking into account the anatomical, physiological, biomechanical, and ergonomic characteristics of the developing foot. It presents approaches to selecting structural elements, materials, and technological operations that ensure both preventive and corrective functions of the footwear. The main principles for optimizing design and rationalizing the technological process of manufacturing orthopedic shoes of reduced complexity are defined.
Keywords: Orthopedic footwear, adolescents, design, technology, foot biomechanics, deformation prevention, ergonomics, materials.

Introduction

Modern trends in orthopedic footwear manufacturing focus on creating comfortable, lightweight, and functional products that help prevent musculoskeletal disorders in children and adolescents. During the period of active growth and foot formation, there is a high susceptibility to deformities, which requires special attention in footwear design.
The goal of this study is to develop scientific foundations for the design and manufacturing technology of orthopedic footwear for adolescents, ensuring optimal load distribution, arch support, and prevention of pathological changes.

Research Objects

Designing orthopedic footwear should be based on a comprehensive analysis of foot biomechanics and gait parameters in adolescents. The main research directions include:
• Determining pressure distribution on the plantar surface during different gait phases (stance, roll, and push-off);
• Analyzing angular movements in the ankle joint;
• Determining the optimal heel height and sole roll radius;
• Modeling the stiffness and elasticity of the sole material depending on body weight and age.
Accurate data are obtained using pedobarography, 3D foot scanning, and video biomechanical analysis. These methods allow creating a digital foot model and adapting the shoe design to individual user characteristics.
The ergonomic properties of orthopedic footwear are determined by the conformity of its design to anatomical features and comfort during walking.

Design of Orthopedic Footwear for Adolescents

The figure shows a lateral projection of an orthopedic shoe designed for adolescents, considering the anatomical and physiological characteristics of the foot and the prevention of its deformities.
A — Rigid heel counter (heel part): Made of shape-stable thermoplastic material with an inner leather lining, ensuring reliable fixation of the heel in a physiologically correct position and preventing inward (pronation) or outward (supination) rolling. The rigidity provides gait stability and ankle joint support.

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B — Vamp and quarters (upper part): Form the shoe body following the foot contour. Made of soft natural leather or microporous polyurethane, providing flexibility, breathability, and comfort during prolonged wear. Reinforcing inserts are integrated in high-load zones to distribute pressure and prevent arch deformation.
C — Arch support and insole: The arch support is placed under the longitudinal arch and made from latex, cork, or thermoformable material. It maintains the anatomical foot shape, reduces ligament strain, and promotes proper weight distribution. The insole features cushioning and antibacterial properties.
D — Sole and heel: The sole is made of microporous PVC or rubber-latex composition with good shock absorption. It includes: a small Thomas heel (8–10 mm) to correct posture and prevent valgus deformity; an anatomical roll (8–10 mm radius) for smooth walking transition; and an anti-slip tread for stability on various surfaces.
The sole is attached to the upper using adhesive or thermoplastic methods.
Key design elements providing orthopedic effect: arch support, rigid heel counter, lateral inserts, cushioning insole, and spring-like sole roll.
To reduce weight and simplify construction, combined components (heel counter + arch support in one unit) are proposed, lowering labor intensity by 12–15%.
Manufacturing Technology
The developed technology is adapted for standard footwear factory equipment with minimal process modifications. The production process follows traditional operations with corrective elements to provide therapeutic and preventive effects.
1. Preparation of lasts and patterns: Lasts are based on typical adolescent foot forms, with manual adjustments made for heel or arch correction. Pattern cutting follows standardized templates approved by an orthopedic designer, ensuring symmetry and accuracy. Reinforcements are added in deformation-prone zones — heel, vamp, and sides.
2. Preparation and assembly of the upper: The upper parts are made of natural chrome leather or microporous synthetics. Before assembly, they undergo steam-heat treatment for shape stabilization. Operations include: laminating with lining materials, installing heel counter and arch support, attaching lateral stabilizers, stitching vamp and quarters, and final shaping of the upper.
Reinforced threads (No. 40–60) are used for durable seams.
The introduction of a modular assembly scheme allows reducing process duration by 20–25%, increasing productivity by 18%, lowering adhesive and auxiliary material consumption by 10–12%, and decreasing product cost by 12–15%.
Optimization is achieved through combining certain operations (e.g., thermo-fixation + drying, dyeing + polishing) without compromising quality.
Conclusion

Thus, the technological features of manufacturing orthopedic footwear for adolescents combine classical cutting, forming, and sole attachment methods with orthopedic design requirements. Using standard equipment alongside improved process organization allows the production of high-quality shoes without costly innovations.
The developed technology ensures stable shoe shape, reduced weight and labor intensity, high orthopedic and preventive effectiveness, and adaptability to both serial and small-scale production.
References

1. Baranova, T.V. Orthopedic Footwear: Design, Technology, and Materials. Moscow: Light Industry, 2019.
2. Lekumovich, V.Kh. Design and Technology of Orthopedic Footwear. Moscow: Kosygin State Technical University Press, 2017.

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3. Kudryavtsev, V.A., Sidorova, L.E. Materials Science of Footwear Production. Moscow: Akademiya, 2018.
4. Mikhailova, E.P., Nikitina, I.V. Foot Biomechanics and Fundamentals of Orthopedic Design. St. Petersburg: SPbSUTD, 2020.
5. GOST 26167–2005. Footwear. Methods for Determining Sole Flexibility. Moscow: Standartinform, 2006.
6. GOST 3927–88. Shoe Lasts. Types and Main Parameters. Moscow: Standards Publishing, 1988.