JUSTIFICATION OF "ANTHROPOMETRIC-FUNCTIONAL" INDICATORS FOR PREVENTIVE-THERAPEUTIC CLOTHING FOR SCHOOL-AGE CHILDREN

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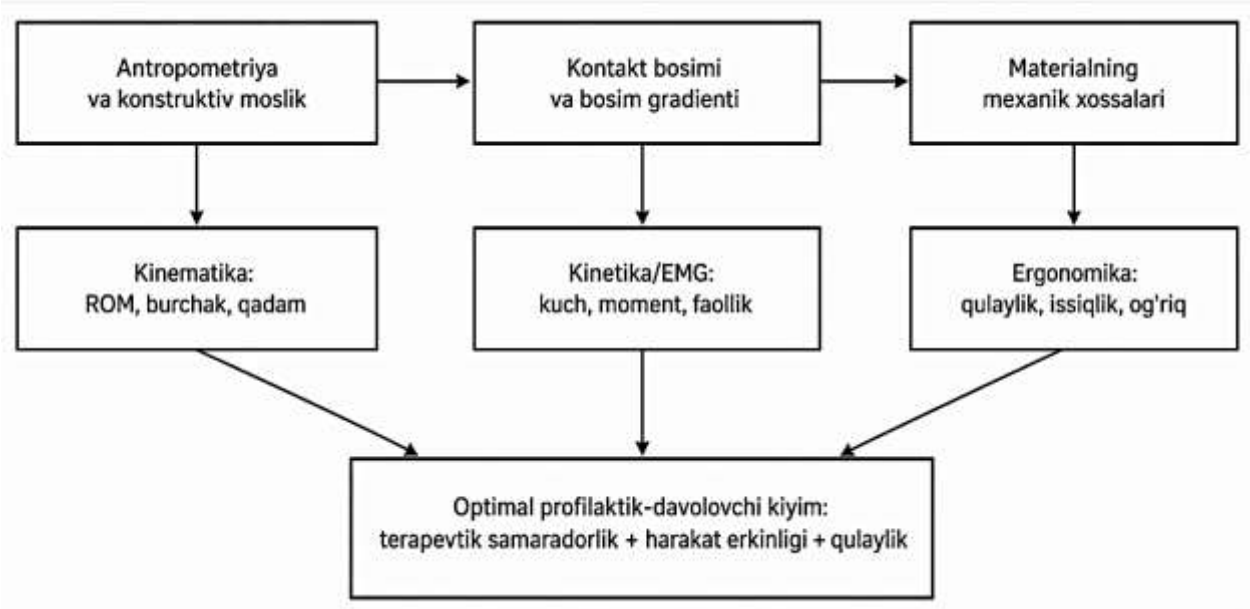
Abstract. Given that preventive-therapeutic clothing for school-age children maintains prolonged mechanical contact with the body, evaluating its effectiveness solely based on anthropometric fit is insufficient. This article develops a methodology for the comprehensive assessment of ergonomic and biomechanical indicators, using compression and functional therapeutic garments for children as a case study. The results demonstrate that therapeutic efficacy is determined not by maximum pressure, but by the balance between standardized pressure across anatomical zones, physiological freedom of movement, and comfort during use.

Keywords: preventive-therapeutic clothing, ergonomics, biomechanics, compression clothing, contact pressure, ROM, sEMG, proprioception, comfort.

Introduction. Preventive and therapeutic garments for school-age children—including elastic knitwear, products for venous and lymphatic insufficiency, joint and muscle-stabilizing apparel, and functional rehabilitation clothing—must ensure an appropriate level of comfort in relation to the human body. Consequently, their quality indicators must encompass not only the characteristics typical of ordinary clothing but also factors such as fit, the contact mechanics and kinematics of the clothing-body system, and subjective comfort.

Therefore, the aim of this study is to systematize the ergonomic and biomechanical indicators of preventive-therapeutic clothing for children based on modern scientific principles and to develop a set of practical criteria for their experimental evaluation. The study hypothesis posits that therapeutic efficacy is achieved not through maximum pressure, but rather through the anatomical differentiation of contact pressure, the preservation of range of motion, and the assurance of user comfort. It illustrates the interrelationship of key factors in the ergonomic design of preventive-therapeutic clothing for school-age children. The conformity of the clothing's construction to anthropometric measurements directly affects the amplitude of human movement, joint angles, and gait parameters. Furthermore, the contact pressure between the clothing and the body—and its distribution—is linked to muscle activity, force, and torque, all of which can be assessed via electromyography (EMG). Materialning cho‘ziluvchanligi, elastikligi, qattiqligi va deformatsion xususiyatlari esa kiyimning tana bilan o‘zaro ta’siri

hamda ergonomik qulayligini belgilaydi. Mazkur ko‘rsatkichlarni kompleks baholash terapevtik samaradorlikni saqlagan holda harakat erkinligi va fiziologik qulaylikni ta’minlovchi optimal profilaktik-davolovchi kiyim konstruksiyasini ishlab chiqishga imkon beradi. (1-rasm)



1-rasm. Profilaktik-davolovchi kiyimni ergonomik va biomekanik baholashning integrallashgan modeli

Maktab yoshidagi bolalar uchun profilaktik-davolovchi kiyimlarni ergonomik baholashda bolaning kundalik faoliyatiga xos tik turish, yurish, o‘tirish, qo‘llarni yuqoriga ko‘tarish, oldinga va yon tomonga egilish harakatlari asosiy funksional sinovlar sifatida qo‘llanilishi mumkin. Ushbu harakatlar davomida kiyim konstruksiyasining tana bilan mosligi, bo‘g‘imlarning harakat diapazoni (ROM), matoning deformatsiyasi, lokal bosim va harakat erkinligi baholanadi. Ilmiy tadqiqotlarda davolovchi kompression va funksional kiyimlar tana yuzasiga mexanik ta’sir ko‘rsatishi, ayrim hollarda proprioseptiv sezgirlik va mushaklarni stabilizatsiyalashga yordam berishi aniqlangan [1,6]. Shu bilan birga, ortiqcha taranglik yoki noto‘g‘ri joylashtirilgan konstruktiv elementlar tizza, tirsak, yelka va bel sohalarida harakat amplitudasining kamayishiga hamda noqulaylikka olib kelishi mumkin [7]. Shuning uchun bolalar uchun profilaktik-davolovchi kiyim harakatni cheklamasligi, tana holatini fiziologik jihatdan qo‘llab-quvvatlashi va bosimni anatomik zonalar bo‘yicha maqbul taqsimlashi lozim.

Bolalar uchun profilaktik-davolovchi kiyimning ergonomik va konstruktiv mosligini baholashda qo‘llaniladigan asosiy funksional holatlarni ifodalaydi. Tik turish, yurish, o‘tirish, qo‘llarni ko‘tarish, oldinga va yon tomonga egilish jarayonlarida kiyimning tana harakatlariga moslashuvi, harakat amplitudasini cheklamasligi hamda materialning deformatsion xususiyatlari baholanadi. Mazkur harakatlar davomida yelka, tirsak, bel, son va tizza sohalarida yuzaga keladigan cho‘zilish, siqilish va kontakt bosimining

o‘zgarishi aniqlanib, kiyim konstruksiyasining funksionalligi va ergonomik qulayligi baholanadi.

Konstruktiv optimallashtirish va amaliy loyihalash mezonlari:

Birinchi mezon bu individuallashtirish. Tana geometrik shakidagi farqlar sabab bir nominal o‘lchamdagi ikki foydalanuvchida kontakt bosimi bir xil bo‘lmasligi mumkin. 3D body scanning, parametrik lekalo va finite-element modellashtirishni birlashtirish orqali bosimni oldindan prognozlash va prototiplar sonini kamaytirish mumkin [8]. Amaliy jihatdan kiyimning maqsad bosim diapazoni, ruxsat etilgan maksimal lokal bosim, minimal ROM saqlanishi va komfort chegaralari texnik topshiriqda oldindan belgilanishi kerak. Shunda konstruktorlik ishida o‘lchanadigan ergonomik-biomexanik mezonlarga tayanadi.

Ikkinchi mezon termofiziologik qulaylik. Bosimni kuchaygan sari havo almashinuvi kamayishi va lokal issiqlik ortishi mumkin [1,9,10]. Shuning uchun namlikni tashuvchi tolalar, g‘ovak zonalar, ventilatsion panellar va teri bilan kontakt qiluvchi yumshoq qatlamlar bosim funksiyasini buzmagan holda mikroiqlimni boshqarishi lozim. Konstruktsiyada yassi choklar, choklarni bosim sezgir zonalardan chetlashtirish va ishqalanishga moyil nuqtalarda chok qalinligini kamaytirish ham muhim.

Uchinchi mezon harakat zonalarini erkinlashtirish. Bo‘g‘im ustidagi ortiqcha material tarangligi ROMni kamaytirishi mumkin; limfedema va bandaging bo‘yicha kinematik ma’lumotlar bunday cheklanish kundalik funksional faollik uchun klinik ahamiyatli bo‘lishini ko‘rsatadi [5]. Shu sabab tirsak, tizza, son va yelka bo‘g‘imlari uchun 3D antropometriya hamda harakatdagi tana yuzasi deformatsiyasidan kelib chiqadigan konstruktiv qo‘shimchalar qo‘llanishi kerak.

To‘rtinchi mezon anatomik zonalash. Katta mushak massivlarida terapevtik yoki stabilizatsion kompressiya yetarli bo‘lishi, tizza osti, tirsak bukilmasi, suyak chiqintilari va nerv-tomir tuzilmalari yaqinida esa lokal bosim piklari cheklanishi lozim. Bu maqsadga turli elastiklikdagi panellar, trikotaj zichligini o‘zgartirish, kesim chiziqlarini ko‘chirish yoki bosimni tarqatuvchi yumshoq interfeys qatlamlari orqali erishish mumkin. 2026-yilgi bosim sezgirligi tadqiqoti turli anatomik nuqtalardagi sezgirlik farqlarini tasdiqlaganligi sababli bir xil sirkulyar bosim darajasi ergonomik jihatdan yetarli emas [9].

Profilaktik-davolovchi kiyimni loyihalashda kompressiya darajasi materialning elastik moduli, cho‘zilish yo‘nalishi, buyum detalining geometrik shakli va tana yuzasining egriligi bilan birgalikda boshqarilishi kerak. Trikotaj tuzilishi va elastik ip parametrlari bosimni sezilarli o‘zgartirishi mumkin[6], g‘ovaklik va material qattiqligi esa tana yuzasidagi biomexanik kuchni taqsimotiga ta’sir qilishi ko‘rsatilgan [7]. Demak, konstruktiv optimallashtirish faqat o‘lchamni kichraytirish yoki materialni kuchliroq cho‘zish orqali bajarilmasligi kerak.

Xulosa qilib aytilganda Maktab yoshidagi bolalar profilaktik-davolovchi kiyimning ergonomik va biomexanik samaradorligi kontakt bosimi, material xususiyati, antropometrik shakli, harakat kinematikasi va subyektiv qulayligi o‘zaro bog‘langan tizimi sifatida baholanishi kerak. Ilmiy tahlillar bosim yumshoq to‘qimalar tebranishini

kamaytirishi, ayrim sharoitlarda proprioseptiv aniqlik va qon aylanishini yaxshilashi mumkinligini ko‘rsatadi. Biroq kuch tiklanishi, kinematika va fiziologik xususiyatlar bo‘yicha natijalar bir xil emas. Shu sabab maksimal bosim optimal dizayn mezoni bo‘la olmaydi.

Integrallashgan yondashuv individual antropometriyaga mos, biomexanik jihatdan xavfsiz va terapevtik jihatdan asoslangan bolalar uchun profilaktik-davolovchi kiyimlarni yaratish uchun ilmiy-metodik baza bo‘lib xizmat qiladi.

Foydalanilgan adabiyotlar

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