

RISK-ORIENTED TRANSFORMATION OF THERAPEUTIC AND PREVENTIVE NUTRITION FOR WORKERS

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Abstract

Relevance. Milk provision to employees exposed to hazardous working conditions remains a large-scale social guarantee in Kazakhstan. However, a universal food product does not account for differences in toxicant properties, exposure intensity, occupational risk, nutritional status, or individual contraindications.

Objective. To formulate a two-component framework for risk-oriented occupational nutrition that preserves workers' statutory and contractual guarantees, and to specify its implementation and evaluation requirements.

Materials and Methods. This was a critical secondary documentary analysis and conceptual policy study, not a systematic review. The documentary corpus comprised statistical, regulatory, organizational, economic and biomedical materials available to the authors, together with accessible public primary sources used to verify legal and statistical claims. No comprehensive bibliographic search, formal study-selection flow or risk-of-bias assessment was undertaken. Narrative synthesis distinguished externally reported observations, authors' arithmetic calculations and conceptual proposals.

Results. The analysis produced a two-component framework linking preservation of existing guarantees with exposure-specific nutritional assessment and product evaluation. It specified a staged decision process covering exposure characterization, individual suitability, product documentation, worker participation and controlled evaluation. Official statistics record 325,429 recipients of milk or equivalent products in the surveyed enterprise population in 2025. Organizational material identifies implementation issues, while the economic analysis specifies the inputs required for a reproducible future full-cost comparison. Incomplete enterprise documentation limits assessment of implementation outcomes. Historical biomonitoring values attributed to the Kola Mining and Metallurgical Company were excluded from quantitative analysis because the original report and essential methodological information were unavailable.

Conclusions. The framework provides a structured basis for developing and testing differentiated occupational nutrition while maintaining mandatory provision. It links legal guarantees with requirements for product selection and evaluation. Preventive efficacy, safety, acceptability and cost-effectiveness require prospective assessment.

Keywords: occupational risk, hazardous working conditions, therapeutic and preventive nutrition, milk, pectin, pectin-enriched preventive beverages, social guarantees, biomonitoring, Kazakhstan.

Introduction

Food provision for employees in hazardous working conditions combines nutritional support with protection of social entitlements. Differentiated

occupational nutrition therefore requires a framework connecting exposure characteristics and individual suitability with enforceable provision rules and measurable outcomes.

A proposed preventive intervention requires a defined exposure, a specified product and dose, indications and contraindications, and outcomes that can distinguish an intervention effect from changes in working conditions. Nutrition must complement, rather than displace, control of hazardous exposure. Legal requirements for food provision do not establish the efficacy of a particular product [1; 2].

The Bureau of National Statistics (BNS) reported 325,429 workers receiving milk or equivalent food products within the surveyed enterprise population in 2025 [3]. This indicator describes reported receipt, rather than all legally eligible workers or verified individual consumption. Table 1 presents the corresponding expenditure data.

The policy context includes the Safe Labour Concept for 2024-2030 [4] and the ILO global occupational safety strategy [5]. An internal RNIOT project summary from Scientific and Technical Program IRN BR22182673 provides additional organizational context [6]. This unpublished project material is used only as contextual documentary evidence and does not establish a health benefit.

The objective was to formulate a two-component framework for risk-oriented occupational nutrition that preserves statutory and contractual guarantees and specifies implementation and evaluation requirements. The proposed framework connects existing entitlements, exposure-specific product assessment and a staged evaluation process.

Materials and methods

Study design and document selection. This study was a critical secondary documentary analysis and conceptual policy study; it was not designed or conducted as a systematic review. No comprehensive database search, PRISMA-type study selection, meta-analysis or formal risk-of-bias assessment was performed. The documentary corpus consisted of materials available to the project team that directly informed one or more predefined analytic domains: (1) national coverage and expenditure, (2) legal requirements, (3) organizational implementation issues, and (4) biomedical rationale and evaluation requirements. Accessible public primary sources were additionally checked to verify legal and statistical claims. Materials without sufficient provenance or methodological information for quantitative interpretation were not used to estimate intervention effects. Full RNIOT implementation records and individual-level laboratory data were not available; these omissions limit the analysis.

Evidence integration. Four analytic streams were considered separately: coverage and expenditure; legal requirements; organizational context; and biomedical rationale and measurement requirements. Documents were used only for the domain(s) to which their content directly applied. Statements were classified as externally reported observations, arithmetic findings or author proposals. Narrative synthesis linked legal and organizational requirements to the framework and biomedical evidence to the proposed future evaluation protocol. Differences in populations, exposures and observation periods precluded any pooled intervention-effect estimate.

Statistical sources. The BNS release and its 2025 statistical tables [3] cover legal entities and/or their structural and separate subdivisions in the specified sectors, excluding small enterprises engaged in entrepreneurial activity. Recipient counts are reported in worksheet “3”, cell F5, and worksheet “4”; expenditure on milk or equivalent foods and therapeutic and preventive nutrition is reported in worksheet “5”, cells G6 and F6. Milk-related expenditure for organizations in state ownership is reported in worksheet “11”, cell G7. Expenditure is expressed in thousands of Kazakhstani tenge (KZT). The aggregate expenditure-to-recipient ratio was calculated after converting expenditure to tenge.

Organizational stream. The organizational material was an internal RNIOT project summary from Scientific and Technical Program IRN BR22182673 [6]. Because the accessible document does not provide enterprise identities, a reproducible enterprise-selection procedure, invitation and response counts, dates and duration, participant roles and numbers, or the modes of feedback collection, no numerical claim about the number of enterprises was used as independently verifiable evidence. The material was therefore used only to identify reported implementation issues, not to estimate prevalence, uptake or effectiveness.

Document-level thematic categorization. The available internal project summary [6] was read in full. Reported issues were grouped descriptively into four categories: exposure duration and sector, assessment transparency, product substitution, and preservation of guarantees. Attribution to employers was retained only where explicit in the source. This was a document-level categorization, not a qualitative study: respondent-level interpretation, theme frequencies, coding reliability and saturation cannot

be assessed because original questionnaires or transcripts were not available.

Biomedical stream. Historical aggregate biomonitoring values attributed in the supplied materials to a Kola Mining and Metallurgical Company report were reviewed for provenance. The original report, sample size, meaning of the reported dispersion values, product dose, laboratory method and exposure data were unavailable. Because these minimum methodological elements could not be verified, the Kola values were excluded from quantitative presentation and were not used as evidence of intervention effect. The published 2018 study by Trofimova et al. concerns workers in the Norilsk region [7] and is treated as a separate source; its methods and results were not transferred to the unverified Kola material.

Economic stream. The internal project summary [6] contains two aggregate annual scenario totals for 100 workers and 250 working days, but it does not report the price year, product portion, procurement unit prices, itemized logistics costs or a reproducible composition of total costs. Because these inputs are insufficient for an independently reproducible comparison, the two scenario totals were not used to claim savings, cost minimization

or cost-effectiveness. The economic contribution of the present analysis is therefore limited to identifying the inputs required for a future full-cost comparison; missing prices were not reconstructed or replaced with current market quotations.

Analysis and data governance. Quantitative calculations were restricted to values whose source and arithmetic basis could be checked from the available materials. The unverified Kola biomonitoring values were excluded from quantitative analysis. The analysis distinguishes externally reported observations, authors' arithmetic calculations and proposed evaluation procedures. No new participant recruitment or identifiable worker data formed part of this analysis. Ethics approval, consent and data-access information for the historical and enterprise work are unavailable and cannot be inferred.

Results

Scale and economic structure of the guarantee

In 2025, the surveyed enterprises reported 325,429 recipients of milk or equivalent food products. Expenditure on these products totalled KZT 14.91 billion, and expenditure on therapeutic and preventive nutrition totalled KZT 42.87 billion (Table 1).

Table 1. Provision of preventive nutrition in Kazakhstan, 2025

Indicator	Value
Workers receiving milk or equivalent foods within the surveyed population	325,429 persons
Expenditure on milk or equivalent foods	KZT 14,910,963.1 thousand
Expenditure on therapeutic and preventive nutrition	KZT 42,871,098.7 thousand
Aggregate milk expenditure per reported recipient in 2025	KZT 45,819.4
Expenditure on milk or equivalent foods by organizations in state ownership	KZT 3,515,791.6 thousand

Source: BNS statistical tables for 2025 [3], worksheet "3", cell F5; worksheet "5", cells F6–G6; worksheet "11", cell G7. The expenditure-to-recipient ratio was calculated as $14,910,963.1 \times 1,000 / 325,429 = \text{KZT } 45,819.4$ per reported recipient in 2025. This aggregate ratio does not measure individual consumption, a statutory allowance or expenditure per person-year of exposure.

Mangystau, Pavlodar and Karaganda regions reported 40,021, 37,454 and 36,662 recipients, respectively [3]. Together, these regions accounted for 114,137 recipients, or 35.1% of the national total within the surveyed population. Expenditure on therapeutic and preventive nutrition was approximately KZT 22.7 billion in mining and quarrying and KZT 10.2 billion in metallurgy. Expenditure on

milk or equivalent foods in mining and quarrying was approximately KZT 4.7 billion [3].

Applicable requirements and proposed change. Annex 1 to Order No. 1056 specifies 0.5 L of milk per shift, regardless of shift duration, on days of actual work with the listed substances [1]. Article 182(2) (4) of the Labour Code establishes the employer's duty to provide milk or equivalent foodstuffs and/

or food products for therapeutic and preventive dietary nutrition according to standards established by the authorized state labour authority [2]. The framework uses these provisions as its entitlement baseline. No independent right to cash substitution is inferred in this analysis; any replacement or alternative provision must comply with the current applicable rules and should be legally verified before implementation. Order No. 1056, the Labour Code and the amendment of 15 June 2026 No. 243 were rechecked against the official Adilet legal information system on 3 October 2026 [1; 2; 8].

Product suitability and requirements for economic evaluation

Milk provides nutrients; selection of occupational nutrition also requires consideration of the relevant exposure and individual clinical suitability, including milk-protein allergy and lactose intolerance. A differentiated approach consequently requires

assessment of both the conventional product and any proposed alternative for the specific workforce and intended outcome.

The internal project material contained aggregate scenario totals for alternative provision, but the underlying price year, portion size, procurement prices and cost composition were not available [6]. The figures are therefore not reproduced as evidence of savings. No cost-effectiveness or cost-minimization conclusion is drawn. A reproducible economic evaluation would require product-specific dosing, comparable health outcomes and a complete, time-referenced cost inventory.

Functional model of targeted nutrition

Table 2 summarizes the regulatory and physiological rationale for candidate product components. It distinguishes documented nutrient functions and product-specific observations from occupational-prevention hypotheses requiring evaluation.

Table 2. Evidence and evaluation requirements for candidate preventive products

Component or task	Support and limits
Pectin and gastrointestinal binding	Regulatory rationale for lead-related ration No. 3 [1; 8]; separate worker study [7]. Recent literature on pectin–metal binding describes physicochemical adsorption mechanisms [9], but material-level adsorption evidence is not proof of in-vivo efficacy against nickel, all metals or inhaled exposure.
Vitamins C and E and oxidative processes	Established antioxidant functions [10; 11]. A randomized trial in power-plant workers reported changes in oxidative-stress and hematological markers after vitamins C and/or E [12], while a 2024 occupational study associated heavy-metal exposure with altered antioxidant status without testing a nutritional intervention [13]. These studies do not establish prevention of occupational disease or efficacy of the proposed product for the target workforce; dose, exposure and safety are context-specific.
Thiamin and energy metabolism	Thiamin has a physiological role in energy metabolism [14]. This does not establish detoxification or protection against a particular occupational agent.
Target-organ protection	“Hepatoprotective” and “nephroprotective” effects are not established for the proposed products. No specific active ingredient, dose or controlled organ-function outcome is available.
Other proposed ingredients	Starch, phytic acid, flavonoids, vitamin A, unspecified minerals, niacin, succinic/citric acids and energy substrates: no component-specific evidence of occupational efficacy was identified in the materials reviewed. These remain research candidates; no effective dose is proposed.
Adaptation	Separate study [7] reports adaptation-related outcomes for its formulation; this is not evidence of a generic adaptogenic effect or validation of the present model. No unspecified “adaptogen” is recommended.

Sources: [1; 7; 8–14]. The table summarizes supporting evidence and its limitations. Occupational and mechanistic studies are cited only within their specific exposure, formulation and design constraints.

For a candidate product, the relevant substance, route and intensity of exposure, composition, dose, duration and safety must be specified before selecting evaluation outcomes. A gastrointestinal binding rationale cannot be assumed to reduce inhalational absorption or systemic burden. Neither a recommendation reported in an external study nor compliance with a food-safety regulation establishes comparative efficacy for Kazakhstani workers [7; 15].

Historical biomonitoring material excluded from quantitative analysis

The supplied materials contained aggregate urinary metal values attributed to a Kola Mining and Metallurgical Company report. The original report could not be located in the available materials, and essential information was missing, including sample size, interpretation of the “±” values, observation duration, product composition and dose, adherence, contemporaneous exposure, laboratory method, sampling protocol and quality-control procedures. Because these data cannot be independently verified or methodologically interpreted, they are not reproduced in a table and are not used to support efficacy, safety or mechanistic claims. Their exclusion reduces the risk of over-interpreting unverifiable historical data.

Organizational issues reported in the project summary

The internal project summary [6] attributes to employers proposals to account for time in hazardous work and sectoral coefficients, to make risk assessment transparent, and to consider targeted products. These proposals correspond to the first three categories described in Methods; preservation of guarantees forms the fourth category. Their frequencies and distribution across enterprises cannot be determined from the accessible document. The statement about possible worker dissatisfaction is an anticipated concern in the summary, not direct evidence of workers' opinions. No separately identifiable worker responses are available. The summary mentions implementation acts, but copies, dates, signatories and applied procedures were unavailable. An implementation act would document an administrative step but would not establish health effects or product acceptability. Uniform implementation and effectiveness across enterprises are therefore not established.

Structure of the proposed two-component framework

The proposed framework connects two components. The guarantee component documents and

preserves mandatory nutrition provision and existing contractual entitlements, establishes responsibility for delivery and provides worker participation and a complaint procedure. Additional social support can be specified in collective or local arrangements within the applicable legal framework. The targeted-nutrition component assesses the exposure and individual nutritional needs, defines candidate-product requirements and subjects additional or legally permissible alternative provision to product-specific evaluation. A shared record for each worker group and a defined decision process link the components; a research intervention does not suspend the guarantee baseline.

Discussion

The framework combines statistical, organizational and biomedical information. Coverage data establish the scale of provision [3]; organizational material identifies implementation issues; and biomedical and economic assessment defines information needed to evaluate product choice. These sources inform the framework's design; its health impact remains to be evaluated.

Product assessment requires documented composition, indications, contraindications and safety/conformity information under applicable food regulations [15]. The separate Norilsk study [7] provides product-specific external context. Its population, formulation and methods should be considered only within the limits of that study and do not validate other products or undocumented historical workplace observations.

Framework contribution. Within the source set reviewed here, the legal sources define statutory provision and entitlement requirements without testing the effectiveness of a specific nutritional product [1; 2; 8], whereas the product-specific study evaluates one pectin-enriched formulation in one workforce and does not address the Kazakh entitlement architecture [7]. The proposed model therefore does not claim a new biological effect; its conceptual contribution is to connect preservation of mandatory provision, exposure-specific product specification, worker participation, and a prospective evidence gate before any broader implementation. These components were selected because they correspond to the four analytic domains used in the documentary analysis: coverage/cost, legal requirements, organizational implementation, and biomedical evaluation.

Recent evidence also reinforces the need to keep biological plausibility separate from product effectiveness. In a randomized trial of 91 power-plant workers, vitamins C and/or E were associated with changes in oxidative-stress and hematological markers over 90 days, but the exposure was extremely low-frequency electromagnetic fields rather than metal exposure [12]. A 2024 occupational study reported higher heavy-metal burden and altered antioxidant status across exposed worker groups, but it was observational and did not evaluate a nutritional intervention [13]. A 2022 review describes pectin-metal adsorption mechanisms in material systems [9]; such physicochemical evidence cannot be transferred directly to in-vivo occupational prevention.

Prospective biomonitoring should be interpreted alongside contemporaneous exposure assessment and standardized collection. A future protocol should prespecify toxicant species and exposure metrics, sampling timing, urine-dilution adjustment, laboratory quality control, renal-function indicators, adverse events and clinically relevant efficacy outcomes. Without these elements, biomarker changes cannot be attributed to a nutritional intervention.

A future full-cost comparison should use $C = N \times D \times q \times p + \text{transport} + \text{storage} + \text{losses} + \text{distribution} + \text{overheads} + \text{monitoring}$, where N is the number of covered workers, D is the number of eligible shifts per worker per year, q is the portion per shift and p is the price per unit of product. Losses must be represented once, either as additional purchased quantity or a separate cost. For each scenario, the price year, taxes, adherence, delivery and storage conditions, and included/excluded cost categories must be explicit. The available economic material cannot isolate cold-chain savings or support procurement recommendations. Morbidity and lost-work-time outcomes were not measured and must not be assigned assumed monetary benefits.

Proposed implementation and evaluation pathway

The proposed decision process has five stages. First, characterize the exposed worker group and hazardous agents, and document statutory and contractual entitlements. Second, assess nutritional requirements and clinical suitability. Third, specify a candidate product, portion, duration, quality and safety documentation, intended outcome and the legal basis for its relation to existing provision. Fourth, agree the delivery and monitoring arrangements with worker representatives and conduct

a predefined controlled evaluation. Fifth, assess health, safety, acceptability and full-cost outcomes before deciding on further use. Before recruitment, the evaluation protocol should prespecify primary and secondary endpoints, baseline and end-of-intervention time points, any post-intervention follow-up, adherence measures, adverse-event and stopping rules, comparator conditions, and a decision rule for continuation or discontinuation. Numerical thresholds should be justified from product- and exposure-specific evidence rather than created retrospectively. An enterprise implementation act documents an administrative step; decisions on product effectiveness require outcome data.

The guarantee component should identify benefit recipients, delivery responsibility, the applicable minimum and any additional support, including its value, funding and indexation where relevant. Audit of actual provision and an accessible complaint route allow continued provision to be monitored during evaluation. Any substitution must have a valid legal basis; where necessary, amendment of applicable norms would precede its introduction. The targeted-nutrition component should use a protocol specifying enterprise selection, recruitment dates, exposed and comparator groups, product and dose, exposure assessment, validated laboratory methods, adherence and adverse events. Employer and worker feedback should be recorded and analyzed separately. These are proposed operational requirements, not results of completed implementation.

Study limitations

The sources differ in date, geography, purpose and accessibility. The national statistics describe the surveyed enterprise population and do not establish individual consumption, eligibility or health effects. Enterprise selection and implementation protocols and original participant feedback were unavailable. The internal project summary is not a publicly retrievable primary report and therefore provides only contextual organizational information. Historical Kola biomonitoring values were excluded from quantitative presentation because the original report, sample size, dispersion definition, dose, laboratory method and exposure data could not be verified. The internal economic scenario lacks the price year, product portion, procurement unit prices and an itemized cost breakdown, so no savings or economic-effectiveness estimate is reported. Because this is a conceptual documentary analysis rather than an intervention study or systematic review, the

framework itself has not been empirically validated. Its implementation performance, preventive efficacy, safety, acceptability and cost-effectiveness remain questions for prospective assessment.

Conclusions

The analysis formulated a two-component framework linking preservation of workers' statutory and contractual guarantees with exposure-specific nutritional assessment and product evaluation. It specifies how existing entitlements, requirements for product choice and the evaluation process should be connected.

The proposed pathway specifies exposure characterization, individual suitability, product documentation, worker participation, controlled evaluation and assessment of health, safety, acceptability and full costs. It provides a basis for designing enterprise protocols and organizing the information needed for decisions on differentiated nutrition.

Prospective testing is required to establish the framework's implementation performance and the effects of specific products. The available internal economic material is insufficient for a reproducible savings or cost-effectiveness estimate, and unverifiable historical biomonitoring data were not used to infer preventive efficacy. Development and testing should preserve applicable mandatory provision and existing contractual entitlements.

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КӘСІБИ ТӘУЕКЕЛГЕ НЕГІЗДЕЛГЕН ЖҰМЫСКЕРЛЕРДІҢ ЕМДІК-ПРОФИЛАКТИКАЛЫҚ ТАМАҚТАНУЫН ТРАНСФОРМАЦИЯЛАУ

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Аңдатпа

Өзектілігі. Қазақстанда зиянды еңбек жағдайларында жұмыс істейтін қызметкерлерге сүт беру кең ауқымды әлеуметтік кепілдік болып табылады. Алайда әмбебап өнім зиянды факторлардың сипатын, әсер ету қарқындылығын, кәсіби тәуекелді, нутритивтік мәртебені және жеке қарсы көрсетілімдерді толық ескермейді.

Мақсаты. Жұмыскерлердің заңда және шарттарда белгіленген кепілдіктерін сақтай отырып, тәуекелге негізделген тамақтанудың тұжырымдамалық моделін әзірлеу және оны болашақта бағалауға қажетті талаптарды анықтау.

Материалдар мен әдістер. Бұл жүйелі шолу емес, статистикалық, нормативтік, жобалық, экономикалық және биомедициналық материалдарға жүргізілген сыни екінші реттік құжаттық талдау және тұжырымдамалық зерттеу. Құжаттар төрт талдамалық бағытқа тікелей қатыстылығына қарай қарастырылды: қамту мен шығындар, құқықтық талаптар, ұйымдастырушылық мәселелер және биомедициналық негіздеме мен бағалау талаптары. Толық библиографиялық іздеу, PRISMA үлгісіндегі іріктеу және жүйелі қателік қаупін формалды бағалау жүргізілген жоқ. Жұмыскерлер деңгейінде жаңа деректер жиналмады.

Нәтижелері. Міндетті және шарттық кепілдіктерді сақтауды кәсіптік әсерге сай тамақтануды бағалаумен және өнімдерді тексерумен байланыстыратын екі компонентті модель ұсынылды. Әсерді сипаттау, өнімнің жұмыскерге сәйкестігін бағалау, өнім құжаттамасын анықтау, жұмыскерлердің қатысуы және бақыланатын бағалау кезеңдері белгіленді. Ресми деректер бойынша 2025 жылы статистикалық зерттеумен қамтылған кәсіпорындарда 325 429 жұмыскер сүт немесе баламалы өнімдер алған. Ұйымдастырушылық материалдар енгізу мәселелерін сипаттайды, ал экономикалық талдау болашақта толық шығындарды қайталанымды салыстыру үшін қажетті деректерді айқындайды. Түпнұсқа есеп пен негізгі әдістемелік деректері болмаған Кола тау-кен металлургиялық компаниясына жатқызылған тарихи биомониторинг көрсеткіштері сандық талдаудан алынып тасталды.

Қорытындылар. Модель міндетті қамтамасыз етуді сақтай отырып, сараланған кәсіптік тамақтануды әзірлеу мен тексерудің құрылымдық негізін ұсынады. Оның ғылыми үлесі құқықтық кепілдіктерді, әсерге сай өнім талаптарын және бағалау кезеңдерін байланыстырудан тұрады. Профилактикалық тиімділік, қауіпсіздік, жұмыскерлер үшін қолайлылық және экономикалық тиімділік перспективті зерттеуде бағалануға тиіс.

Түйін сөздер: *кәсіптік тәуекел, зиянды еңбек жағдайлары, емдік-профилактикалық тамақтану, сүт, пектин, пектинмен байытылған профилактикалық сусындар, әлеуметтік кепілдіктер, биомониторинг, Қазақстан.*

РИСК-ОРИЕНТИРОВАННАЯ ТРАНСФОРМАЦИЯ ЛЕЧЕБНО-ПРОФИЛАКТИЧЕСКОГО ПИТАНИЯ РАБОТНИКОВ

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Аннотация

Актуальность. Выдача молока работникам, занятым во вредных условиях труда, остаётся масштабной социальной гарантией. Однако универсальный продукт не учитывает свойства токсикантов, интенсивность воздействия, профессиональный риск, нутритивный статус и индивидуальные противопоказания.

Цель. Разработать концептуальную модель риск-ориентированного питания с сохранением законодательно установленных и договорных гарантий работников и определить требования к ее дальнейшей проверке.

Материалы и методы. Работа представляет собой критический вторичный документальный анализ и концептуальное исследование, а не систематический обзор. Документы рассматривались по их прямой относимости к четырем аналитическим направлениям: охват и расходы, правовые требования, организационные вопросы, биомедицинское обоснование и требования к оценке. Всеобъемлющий библиографический поиск, отбор по схеме PRISMA и формальная оценка риска систематической ошибки не проводились. Новые данные на уровне работников не собирались.

Результаты. Предложена двухкомпонентная модель, связывающая сохранение обязательных и договорных гарантий с оценкой питания и продуктов применительно к конкретной производственной экспозиции. Определены этапы характеристики воздействия, оценки соответствия продукта индивидуальным потребностям и противопоказаниям, документирования продукта, участия работников и контролируемой проверки. Официальные данные за 2025 г. указывают на 325 429 получателей молока или равноценных продуктов в обследованном круге предприятий. Организационные материалы описывают вопросы внедрения, а экономический анализ определяет данные, необходимые

для воспроизводимого будущего сравнения полных затрат. Исторические данные биомониторинга, приписываемые Кольской горно-металлургической компании, исключены из количественного анализа из-за отсутствия исходного отчета и ключевых методических сведений.

Выводы. Модель формирует основу для разработки и проверки дифференцированного питания с сохранением обязательного обеспечения работников. Научный вклад заключается в объединении правовых гарантий, требований к выбору продукта с учетом экспозиции и последовательности оценки. Профилактическая эффективность, безопасность, приемлемость для работников и экономическая эффективность подлежат проспективной проверке.

Ключевые слова: профессиональный риск, вредные условия труда, лечебно-профилактическое питание, молоко, пектин, пектинсодержащие профилактические напитки, социальные гарантии, биомониторинг, Казахстан.

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