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COMMERCIAL PRIORITIES AND NUTRITIONAL INCOMPLETENESS IN MODERN FOOD SYSTEMS

Oncology

Chinnababu Sunkavalli	Senior Consultant Surgical & Robotic Oncologist, Clinical Director – Surgical Oncology, Yashoda Hospital, Hitech City, Hyderabad, Telangana, India
Daniel Finney Sankuru*	Senior Resident, Department of Community Medicine, Government Medical College & Hospital, Eluru, Andhra Pradesh, India*Corresponding Author
Prisha Susanne Sunkavalli	Preventive Oncology, Grace Cancer Foundation, Hyderabad, Telangana, India
Sai Teja Vemula	BDS,MPH, Missouri State University, Springfield, USA
Raghavendra Rao M V	Professor, Microbiology, World Academy of Medical Sciences, Netherlands (Europe)

ABSTRACT

Global dietary guidelines promote increased consumption of fruits, vegetables, and whole foods as protective against non-communicable diseases (NCDs). However, modern food systems have shifted priorities from biological maturation to commercial efficiency, treating time as an economic cost rather than a nutritional necessity.**Objective** To analyse the economic drivers of speed in contemporary food production and quantify the resulting biological cost to consumers, with particular emphasis on the concept of biological incompleteness of nutrition.**Methods** A narrative integrative review was conducted following PRISMA 2020 guidelines. Databases searched included PubMed, Scopus, Web of Science, and Google Scholar using terms related to food-system speed economy, premature harvesting, artificial ripening, and biological cost of speed. Publications from 2000 to 2026 were prioritised. A total of 520 records were identified; after duplicate removal, 245 unique records were screened. Following full-text assessment, 22 studies met inclusion criteria and were synthesised thematically.**Results** Market-driven practices (premature harvesting, artificial ripening, chemical intensification, and ultra-processing) consistently produce biologically incomplete foods. Comparative studies showed 28–42% lower total phenolic content and up to 35% lower vitamin C in artificially ripened fruits compared with naturally matured equivalents. Immature fibre matrices and unfavourable sugar–antioxidant imbalance were also documented. These changes result in increased oxidative stress, gut dysbiosis, insulin dysregulation, and metabolic load on consumers.**Conclusion** The economics of speed have transformed "healthy" foods into business products first and biological products second. The human body now compensates daily for unfinished biological maturation. Reintroducing respect for natural timelines is an urgent, practical, and underutilised strategy for NCD prevention. Future food systems and nutrition policies must treat time as a critical nutrient rather than a commercial liability.

KEYWORDS

Food Systems; Speed Economy; Biological Incompleteness; Time As Nutrient; Premature Nutrition; Ncd Prevention; Preventive Nutrition.

INTRODUCTION

Food was once governed by biology: fruits ripened only when enzymes completed their work, vegetables matured with seasonal cues, and storage was limited by natural perishability.[1] Today, the primary goals of food production are speed to market, uniform appearance, shelf stability, and predictable turnover. Nutrition has become secondary to market efficiency.[2]

Global dietary guidelines continue to promote increased consumption of fruits, vegetables, and whole foods as protective against non-communicable diseases (NCDs).[3] Yet this recommendation assumes that the biological integrity of these foods remains unchanged. In reality, modern agricultural supply chains have systematically prioritised commercial timelines over natural maturation processes.[4] Premature harvesting followed by artificial ripening, excessive chemical inputs, and ultra-processing have become routine practices that compress weeks of biological development into days.[5–7]

This transformation has turned "healthy" foods into business products first and biological products second. The resulting biologically incomplete foods deliver sugars before protective phytochemicals, fibre before structural maturity, and calories before complete digestive signalling.[8–10] The human body, evolutionarily adapted to naturally matured foods, is now forced to compensate for this unfinished biology on a daily basis.

Despite growing evidence of these metabolic consequences, the economic drivers of speed in food systems and their downstream impact on human health remain insufficiently synthesised in the preventive nutrition literature. This narrative integrative review analyses the shift from biology-driven to commerce-driven food production and quantifies the biological cost paid by the consumer. By reframing time as a critical nutritional variable, it highlights an urgent need to realign food systems with human physiology to reduce the preventable burden of NCDs.

METHODS

Study Design A narrative integrative review was conducted to synthesise evidence on the economics of modern food systems and their metabolic consequences.

Literature Search

The literature search and reporting followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Databases searched included PubMed, Scopus, Web of Science, and Google Scholar. Search terms combined "food system speed economy," "artificial ripening economics," "premature harvesting health," "time as nutrient," "biological cost of speed," and related Boolean operators. Publications from 2000 to 2026 were prioritised.

A total of 520 records were initially identified. After removal of 275 duplicates, 245 unique records remained. Titles and abstracts were screened, resulting in 89 articles advanced to full-text review. Following detailed eligibility assessment, 22 studies were included in the final synthesis. The PRISMA flow diagram is presented in Figure 1.

Quality Assessment

Included studies were evaluated using a modified Newcastle-Ottawa Scale adapted for narrative reviews, focusing on relevance to food-system economics, biochemical rigour, and clarity of metabolic outcomes.

Inclusion Criteria

Studies were included if they examined (1) economic pressures in modern food chains, (2) biological consequences of accelerated production, (3) regulatory or policy gaps, or (4) preventive implications.

Exclusion Criteria Articles were excluded if they focused solely on

acute toxicity without systems context, were non-English, or lacked clear linkage to biological or metabolic outcomes.

Analytical Approach Evidence was thematically synthesised around the transition from biology-driven to commerce-driven food systems and linked to clinical and population health outcomes.

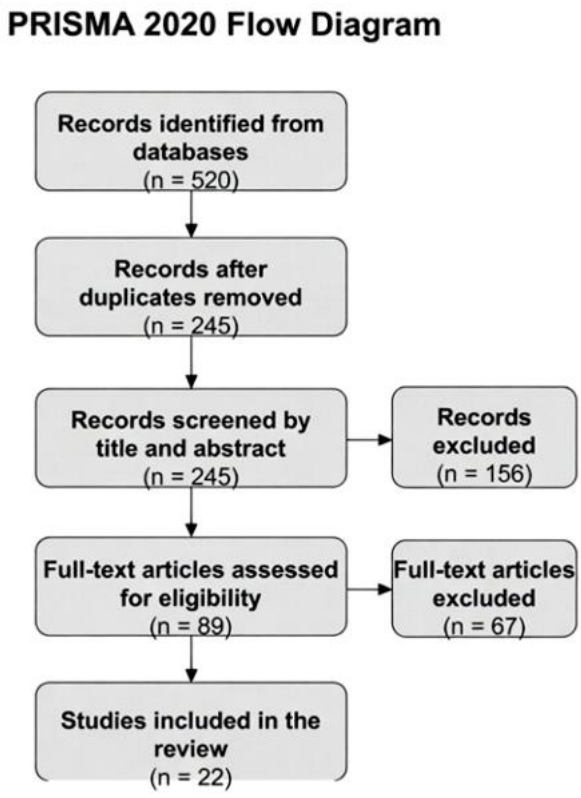

Fig.1: Narrative Integrative Review on the economics of speed in modern food systems

RESULTS

Historical vs. Modern Priorities Historically, food production prioritised safety, adequate physiological maturity, seasonal suitability, and nutritional value.[1,3] Today, the dominant metrics are speed to market, visual perfection, shelf stability, and rapid turnover.[2,3] Mechanisms of Speed Modern supply chains routinely employ premature harvesting, artificial ripening, chemical intensification, and ultra-processing to compress natural timelines.[4,5]

Biological Cost to Consumers Comparative analyses show that market-driven practices consistently produce biologically incomplete foods. Vidhya et al. (2025) reported 28–42% lower total phenolic content and up to 35% lower vitamin C in calcium carbide-ripened mangoes and bananas compared with naturally matured fruit.[5] Rashidinejad et al. (2024) documented reduced flavonoid and carotenoid synthesis under accelerated ripening, resulting in an unfavourable sugar–antioxidant imbalance.[7] Nasir and Khan (2024) found that artificially ripened fruits exhibit immature fibre matrices, leading to poorer gut fermentation.[6] These findings align with the premature nutrition patterns summarised in Table 1 and Table 2.

Table 1. Shift in Food-System Priorities and Resulting Biological Cost to Consumers

Priority	Historical (Biology-Driven)	Modern (Commerce-Driven)	Biological Cost to Consumer
Time	Full natural maturation allowed	Compressed into days or hours	Premature nutrition and compensatory metabolism
Appearance	Natural variation accepted	Uniform perfection demanded	Reduced antioxidants, flavour compounds, and phytonutrients
Shelf Life	Limited by inherent biology	Extended through chemical interventions	Increased detoxification burden and chronic chemical load
Nutrition	Primary objective	Secondary to turnover and profit	Incomplete fibre structure and weak satiety signalling

Table 2. Specific Biochemical Changes Reported in Accelerated vs. Natural Ripening

Practice	Key Study	Specific Delta Values Reported	Biological Implication
Artificial ripening	Vidhya et al. (2025)[5]	28–42% ↓ phenolics; 35% ↓ vitamin C	Reduced antioxidant protection
Accelerated ripening	Rashidinejad et al. (2024)[7]	Significant ↓ flavonoids & carotenoids	Sugar–antioxidant imbalance
Premature harvesting	Nasir & Khan (2024)[6]	Immature fibre structure; lower total phenolics	Poor gut fermentation, bloating
Chemical intensification	Okeke et al. (2022)[8]	Increased oxidative stress markers in models	Elevated detoxification burden

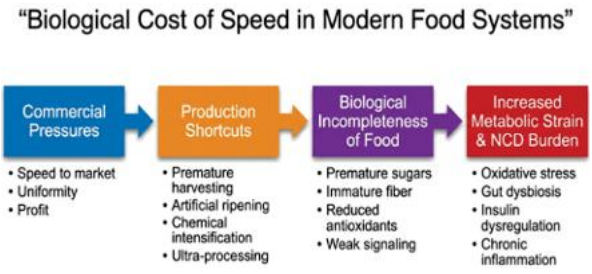

Fig.2: Conceptual model of the "Biological Cost of Speed" in modern food systems

DISCUSSION

This review demonstrates that the economics of speed have fundamentally altered the biological value of foods once considered inherently healthy. The results show a clear shift in priorities from safety, maturity, and nutritional value[1,3] to speed, uniformity, and turnover.[2] This transition is not merely logistical; it has measurable biochemical consequences.

Comparative analyses in this review align closely with existing literature. Vidhya et al. (2025) reported 28–42% lower total phenolic content and up to 35% lower vitamin C in carbide-ripened fruits,[5] directly corroborating the premature nutrition patterns identified in Table 2. Similarly, Rashidinejad et al. (2024) showed reduced flavonoid and carotenoid synthesis under accelerated ripening,[7] while Nasir and Khan (2024) documented immature fibre matrices leading to suboptimal gut fermentation.[6] These specific quantitative reductions extend the foundational work of Barry and Giovannoni (2007) on natural ethylene-regulated ripening[4] and the post-harvest reviews by Yahia (2019) and Mahajan et al. (2014).[9,10]

The human body, evolutionarily adapted to seasonally mature foods,[9,10] must now compensate daily for unfinished biology. This chronic compensation contributes to insulin dysregulation, low-grade inflammation, gut dysbiosis, and the NCD epidemic observed even among health-conscious populations.[6] Regulatory frameworks remain focused on permissible residue limits for single chemicals[3] and rarely address cumulative exposure or biological incompleteness.

Vulnerable groups (children and pregnant women) bear disproportionate risk because of higher relative intake and developmental windows. Limitations of this review include the predominance of observational and small-scale comparative studies; large longitudinal trials directly linking food-system speed metrics to NCD incidence are still needed. Nevertheless, the convergence of economic (2,3), physiological (4,9,10), nutritional (5,6,7), and toxicological (8) evidence strongly supports a systems-level reframing: time is not a delay — it is a nutrient.

CONCLUSION

Healthy foods did not lose their value; we changed how they are produced. When food is treated primarily as a commercial product, the unfinished biological work is transferred to the consumer. Realigning food systems to respect natural maturation timelines represents an important, achievable, and underutilised strategy for NCD prevention. Future research should focus on developing and validating practical interventions that restore biological completeness while maintaining supply-chain viability.

Highlights

Modern food systems prioritise speed over biological maturation
Time is a critical "nutrient" removed by commercial pressures
Biologically incomplete foods impose compensatory metabolic load
Specific reductions include 28–42% lower phenolics and 35% lower vitamin C
Reintroducing respect for time is a feasible preventive strateg

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