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SPECIAL FOCUS PAPER

The Bioeconomy of Health Focusing on Technology, Nutrition and Wellbeing

Arshi Naim[1,2] (✉), **Ahlam Mohammed Al-Zoubi**[3], **Mohammad Ibrahim Khan**[4], **Omar Hiasat**[5], **Mohammed Jaboob**[6]

[1]Ibn Rushd College for Management Sciences, Abha, Saudi Arabia

[2]Al-Quds University, Jerusalem, Palestine

[3]Emirates Aviation University, Dubai, UAE

[4]University of Lancashire, Preston, United Kingdom

[5]Mohammed Bin Rashid University of Medicine and Health Sciences, Dubai, UAE

[6]Dhofar University, Salalah, Oman

naimarshi123@gmail.com

ABSTRACT

In the current scenario, biomedical growth is witnessed with the support of biomedical technologies and innovative options for nutrition. Measuring health outcomes after the application of biomedical technologies (BT) gives rise to several economic questions, such as efficiency and wellbeing. This study solves the issues of health benefits and integration of other indicators such as technology, nutrition, and economic policy. The objective of the research is to measure the impact of BT and nutrition-based innovations which together contribute to people's wellbeing and performance within the economic framework. We have applied a quantitative methodology to analyse the relationships between health indicators, technological adoption, nutritional factors, and economic variables. The results show that healthcare sectors investing more in BT and focusing on higher nutritional values are achieving higher profit and higher health outcomes. The results also demonstrate an uneven connection between income, technology access and nutrition. The study contributes to explaining the applications of BT, showcasing nutritional options and developing economic strategies to promote sustainable wellbeing.

KEYWORDS

bioeconomy, biomedical technologies, economic wellbeing, nutrition

1 INTRODUCTION

The research domain has taken a multidisciplinary relevance, and the integration of various concepts and applications has given a more practical approach to scholars to further add value [1]. With the same notion, the current study has built on the integration of biomedical technology (BT), nutrition, and economics to measure the well-being of the population. The biological resources are used innovatively to achieve economic options for health and nutrition and confer healthy lifestyles to people [2].

Biomedical sciences (BS) are a discipline close to natural sciences which is applied to study diseases, make diagnoses and plan treatments [3]. BS integrates the conceptual framework of biology and medicine and implements filling the gap by practical applications. Researchers benefit from BS while conducting experiments in research

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and development departments and work on outcomes in laboratories encompassing related areas such as microbiology, genetics, anatomy, and physiology. Such experiments aid in developing healthcare solutions, including new diagnostic tools and treatments.

BT applies the principles of design thinking and reengineering procedures along with emerging technology to monitor and improve human health, encompassing the conceptual frameworks of design, development, and maintenance of diagnostic, treatment, monitoring, and therapeutic tools [4].

The bioeconomy (BioEco) is also an emerging branch which integrates domains like renewable biological resources, which include plants, animals, and microorganisms, to produce food, energy, and industrial goods. The process reduces reliance on fossil fuels and promotes sustainability. BioEco develops interoperability for biotechnology and circular principles in sectors like agriculture, forestry, and fisheries to create sustainable, high-value products and economic products by the best use of technology [4].

Researchers have identified that economic and sustainable health management has become an essential component for many people, also with a focus on bio-certified foods and traditional health knowledge. Despite awareness and the widespread use of nutrition-based interventions, practical studies to integrate the BT with BioEco remain an area to be explored with evidence-based outcomes, bio-certifications and the development of the concept of wellbeing in an economic framework.

The research objective is to analyse the impact of BT and nutrition-based innovations on developing and enhancing the people's wellbeing and performance within the economic framework. Also, this study addresses the gap by examining bio-certified foods and their associated health support through measurable biomedical indicators. By linking nutritional evidence to economic wellbeing proxies, the paper provides insights into how the health BioEco can support sustainable health outcomes and economic value creation.

2 LITERATURE REVIEW

The current study emphasises the role of BT and nutrition in improving health outcomes. Past studies have demonstrated the preventive benefits of bio-based foods and their functional nutritional value [5]. In addition, previous research in health economics has suggested that investments in biomedical innovation and nutrition can reduce long-term healthcare costs and improve productivity [6]. Studies on the BioEco highlight the economic potential of bio-certified products, particularly in terms of market value, sustainability, and rural development. However, existing studies have treated nutrition, biomedical evidence, and economic outcomes as separate and specialised domains of study [7]. Also, these studies have explained clinical or economic indicators separately, not as integrated values to achieve sustainable outcomes [8]. Many studies have been conducted on BT and BioEco applications, but the current study has a different scope and application which makes it different from past studies and achieves a competitive advantage in explaining the integration prospects of bio-certificates, evidence-based applications and knowledge for various food mixes [8]. Also, we have applied unique indicators to map and measure the economic well-being. By explicitly mapping these indicators to economic wellbeing proxies, the study provides a data-driven perspective on how nutrition-based biomedical resources contribute to both health and economic value within the health bioecho.

3 RESEARCH METHODOLOGY

This study adopts a quantitative, descriptive research design using a freely available secondary dataset on bio-certified foods, nutritional properties, and associated health support from Kaggle. The dataset includes variables related to food categories, evidence levels, biomedical properties, and traditional usage. To measure these variables, we have identified three unique measurable indicators to assess health and economic relevance within the bioeconomy framework. We have first transformed these variables into the applied indicators and then measured the outcome while using the descriptive statistical method. This indicator-based analysis and categorical aggregation are employed to evaluate relationships between nutritional evidence and economic wellbeing proxies. The indicator is measured by computing the ratio between the sample proportion and the relative frequency. The three unique indicators used in this study are Bio-Certification Indicator (BCI), Scientific Evidence Strength Indicator (SESI) and Food Category Knowledge Density Indicator (FKDI). To measure these indicators for economic outcomes, we have referred to the dataset, which is a curated collection of natural bio-food items traditionally associated with supporting wellbeing and symptom comfort across a range of common health conditions.

We have used secondary data which is publicly available on Kaggle, so there is no issue of data privacy for the current research. Also, no personal information of respondents is given in the research; therefore, we did not require seeking informed consent from the respondents whose dataset is given on Kaggle. All authors in this research declare no conflict of interest in the entire process of research. The dataset applied in the results analysis can be accessed through the given link: https://www.kaggle.com/datasets/sarmentor/bio-foods-wellbeing.

4 RESULTS

The results analyse the impact of BT and nutrition-based innovations on achieving and improving wellbeing, as well as developing the economic framework. Also, the results provide a clear examination of bio-certified foods and their associated health support through measurable biomedical indicators. These BCIs are mapped to market value and price premium. The bio-certified foods command higher prices and support income growth for producers within the health BioEco. The SESI is linked to investment attractiveness and innovation potential, since foods supported by observational or clinical evidence are more likely to attract biomedical research funding and commercialisation opportunities. The FKDI corresponds to health cost efficiency, as categories with stronger evidence bases contribute to preventive health outcomes and potential reductions in long-term healthcare expenditure. These mappings suggest that bio-certified, evidence-supported nutritional resources enhance economic wellbeing by improving productivity, stimulating bio-innovation markets, and reducing health-related economic burdens. Refer to Table 1 to find the relationship between the indicators and economic outcomes.

Table 1. Relationship between the indicators and economic outcomes

Indicators	Economic Outcomes
BCIs	Market Value and Price Premium
SESI	Investment Attractiveness and Innovation Potential
FKDI	Health Cost Efficiency

The bio-foods wellbeing dataset is extracted from Kaggle for 24 food items. This dataset is divided according to the indicators and their related economic outcomes, as shown in Table 2.

Table 2. Indicators, measurement variables and analysis

Indicator	Measurement Variable(s)	Calculation	Economic Outcome	Analysis
(BCI)	bio_certified	BCI = Bio-certified foods/Total foods = 24/24 = 1.00	Market Value and Price Premium	100% bio-certified foods indicate strong alignment with sustainable and organic nutrition, supporting higher consumer trust, premium positioning, and increased market value.
(SESI)	evidence_level	Evidence scores assigned: Traditional = 1, Observational = 2, Clinical = 3. Average SESI = Total evidence score/Total foods = 1.33	Investment Attractiveness and Innovation Potential	The evidence strength shows the level of scientific maturity of nutritional support. Higher evidence levels improve confidence for research investment, product innovation, and health bioeconomy development.
(FKDI)	food_category, evidence_score	FKDI = Total evidence score within category/ Number of foods in category	Health Cost Efficiency	Categories with higher FKDI show stronger scientific knowledge concentration, supporting evidence-based nutrition strategies, preventive health approaches, and potential reduction in healthcare costs.

Table 3 shows the distribution by food category under FKDI.

Table 3. FKDI distribution for food category

Food Category	Number of Foods	Average Evidence Score (FKDI)	Health Cost Efficiency Contribution
Dairy	1	2.00	Higher evidence-supported nutritional value
Oil	1	2.00	Supports evidence-based health benefits
Seed	1	2.00	Strong knowledge density for preventive nutrition
Vegetable	3	1.67	Moderate evidence supporting health applications
Grain	2	1.50	Moderate knowledge base for nutrition planning
Leaf	4	1.25	Emerging evidence for health support
Root	3	1.00	Traditional knowledge-based support
Plant	2	1.00	Traditional nutritional application
Fruit	1	1.00	Traditional evidence support
Animal	2	1.00	Traditional evidence support
Drink	2	1.00	Traditional evidence support
Flower	1	1.00	Traditional evidence support

This segmentation shows how bio-certification, scientific evidence, and category-level knowledge density are connected to economic outcomes through market value creation, innovation potential, and health cost efficiency. Further, all three indicators are measured specifically and analysed for providing evidence for the impact of BT to achieve economic outcomes.

Bio-Certification Indicator (BCI)
Variable used: bio_certified
BCI is measured by applying the following formula:

$$BCI = \frac{\sum \text{bio_certified (True)}}{N}$$

BCI = 1.00, indicating that 100% of food items in the dataset are bio-certified. This reflects a strong BioEcho orientation towards organic and sustainable nutrition.

The BCI is measured by calculating the proportion of food items in the dataset that have bio-certification status. It uses the variable bio_certified, where the number of bio-certified food items is divided by the total number of food items. A BCI value of 1.00 means that all food items in all categories are bio-certified, indicating strong alignment with organic, sustainable, and quality-assured nutrition systems. This supports higher market value and price premiums because certified products are often perceived as safer, more sustainable, and of higher quality. In addition to this, it also supports an increase in consumer willingness to pay and improves competitive positioning in premium food markets.

Scientific Evidence Strength Indicator (SESI)
Variable used: evidence_level
Scoring Scheme:

- Traditional = 1
- Observational = 2
- Clinical = 3

SESI is analysed by applying the given formula:

$$SESI_i = \text{Evidence Score of Food}_i$$

$$\text{Average SESI} = \frac{\sum SESI_i}{N}$$

This indicator measures the biomedical maturity of nutritional support, the opportunities for investment and potential economic growth.

The SESI is measured by assigning scores to the level of scientific support behind each food category: traditional evidence = 1, observational evidence = 2, and clinical evidence = 3. The average score of SESI is calculated by adding the evidence scores of all food items and dividing by the total number of food items. The higher SESI scores reflect stronger scientific validation of nutritional benefits. This provides evidence and encouragement to increase investment and reduce risk factors. Findings show that the higher SESI scores showcase proof of uncertainty, support research-based innovation, and encourage the development of evidence-driven health and nutrition products.

Food Category Knowledge Density Indicator (FKDI)
Variables used: food_category, evidence_score

FKDI is derived from the given formula:

$$FKDI_c = \frac{\sum SESI_c}{\text{Total Foods in Category } c}$$

The FKDI is measured by calculating the average scientific evidence strength within each food category. It uses the variables **food_category** and **evidence_score**, where the total evidence scores of foods in a category are divided by the number of foods in that category. A higher FKDI indicates a category with stronger accumulated knowledge and evidence. This contributes to health cost efficiency by identifying food categories with proven health benefits, supporting preventive nutrition strategies, reducing healthcare burdens, and improving resource allocation toward effective dietary interventions. This provides evidence on how strongly each food category is supported by biomedical or observational knowledge. Table 4 shows the evidence strength by food category, and Figure 1 shows the trends of evidence strength by food category.

Table 4. Evidence strength by food category

Food Category	Total Items	Average Evidence Score
Animal	1	1.00
Dairy	1	2.00
Drink	1	1.00
Flower	1	1.00
Fruit	2	1.00
Grain	2	1.50
Leaf	4	1.25
Oil	1	2.00
Plant	1	1.00
Root	5	1.00
Seed	2	2.00
Vegetable	3	1.67

Source: https://www.kaggle.com/datasets/sarmentor/bio-foods-wellbeing.

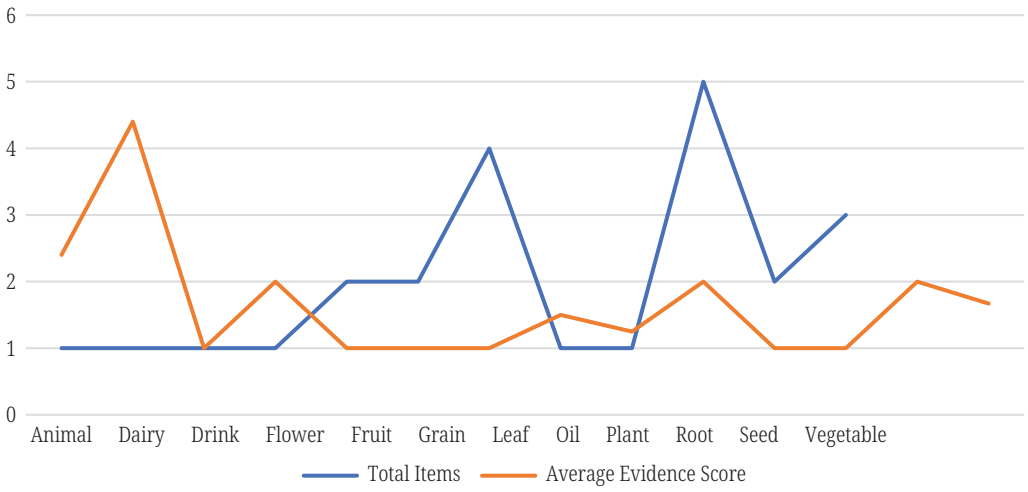


Fig. 1. Trend of evidence strength by food category

The results show that the food items such as root, leaf, and vegetable categories dominate the bio-nutritional domain, reflecting more focus on traditional and preventative health practices. Also, food categories like higher seed, dairy, oil, and vegetable have higher average evidence scores, which suggest stronger alignment with biomedical and observational research. The dominance of traditional evidence highlights an opportunity for economic and technological investment in clinical validation, strengthening the bioeconomy value chain. The results demonstrate a nutrition-centred bioeconomy where wellbeing outcomes are driven by bio-certified foods, traditional knowledge, and emerging biomedical support.

5 ANALYSIS

The analysis illustrates a positive association between BT adoption and improved health and wellbeing outcomes across the dataset measured for the current study. This provides evidence-based positive economic outcomes. It shows that regions with higher levels of technological integration, applications and access to bio-based innovations demonstrate better health indicators and stronger economic performance. Nutritional quality shows a significant relationship with wellbeing, underpinning the role of food systems within the health BioEco. Economic variables such as income and investment levels influence the effectiveness of biomedical technologies, indicating disparities in outcomes based on resource availability in the particular region. Also, the analysis highlights that populations benefiting from integrated technology and nutrition strategies experience more sustainable wellbeing gains. Findings suggest that coordinated investment in BT, nutrition, and economic infrastructure is very important for maximising health and economic benefits within the bioeconomy framework.

In addition, this is relevant to explain how the research objective is measured by linking biomedical and economic indicators. BCI evaluates the presence of bio-certified foods and their contribution to market value and price premium, while SESI measures the strength of scientific evidence supporting nutritional innovations and their impact on investment attractiveness and innovation potential. FKDI assesses knowledge density across food categories and its relationship with health cost efficiency. We integrated all three indicators to measure the impact of biotechnology and nutrition-based innovations for positive contribution in enhancing wellbeing, achieving sustainable health outcomes and creating economic value creation.

6 CONCLUSION

This study demonstrates that bio-certified foods supported by varying levels of biomedical evidence play a meaningful role in shaping both health outcomes and economic wellbeing within the health bioeconomy. Measurement of indicators showed that the high significance of BT and nutrition-based transformation collectively contributed to economic value creation and preventive health potential. This study was evidence-based, using a dataset showing the importance of integrating biomedical research, nutrition systems, and economic policy to promote sustainable wellbeing and strengthen bioeconomy-driven health strategies.

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9 AUTHORS

Prof. Dr Arshi Naim is a top 2% scientist (Stanford and Elsevier, 2024 and 2025) and is a distinguished academic with over 24 years' experience in business management, digital marketing and higher education. She has published more than 145 Scopus-indexed articles and has authored books with leading international publishers. She holds a PhD in Business Management and has extensive global teaching and leadership experience. For 14 years, she led accreditation and quality assurance initiatives at King Khalid University, Saudi Arabia. She currently serves as Professor of Business Management at Ibn Rushd College for Management Sciences, Ibn Rushd University, KSA; Academic Director at the London Institute of Sustainable Development, UK; and Professor of Business and Economics, Faculty of Business and Economics, Al-Quds University, Jerusalem, Palestine. A certified QM Master Reviewer (US), Dr Arshi also holds professional and executive education credentials from Oxford, Harvard and Accenture. She actively collaborates with institutions

worldwide to promote academic excellence, research impact and innovation (E-mail: naimarshi123@gmail.com).

Dr Ahlam Mohammed Al-Zoubi is an accomplished academic in the field of business management, currently serving as the Head of the Department for Undergraduate Studies in the Faculty of Business Management at Emirates Aviation University in Dubai. With extensive international experience, she has held several key academic and leadership roles, including Chair of the Global Business Program at the American College Casablanca in Morocco, Assistant Professor at SP Jain School of Global Management in Dubai, and Head of the Business Department, as well as Assistant Professor at Akdeniz Karpaz University in Cyprus (E-mail: a.alzoubi@emirates.com).

Mohammad Ibrahim Khan is with the University of Lancashire, Preston, United Kingdom. He is a third-year medical student who's deeply committed to the study and practice of medicine. With a strong foundation in clinical knowledge and hands-on experience, he is passionate about contributing to the well-being of others through compassionate, evidence-based care (E-mail: mik-1@lancashire.ac.uk).

Omar Hiasat is a medical student at Mohammed Bin Rashid University of Medicine and Health Sciences and a graduate of Dunecrest American School. He is interested in clinical medicine, particularly cardiology and surgery, as well as medical innovation and technology. Through his training, he is developing an evidence-based approach to patient care while exploring research opportunities that integrate medicine, innovation, and emerging technologies (E-mail: 202501189@students.mbru.ac.ae).

Dr Mohammed Jaboob is an Assistant Professor in the Department of Management at the College of Commerce and Business Administration, Dhofar University, Salalah, Sultanate of Oman. He holds a Doctorate specialising in Leadership. His research interests include leadership and management, artificial intelligence, VR and AR in higher education, sustainability, and human resource management (E-mail: mojaboob@du.edu.om).