The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 6, 2025

AI AND NUTRITION IN CANCER: FROM RISK PREDICTION TO DIETARY SUPPORT DURING TREATMENT WITH CONSIDERATION OF ACPS

Amna Imran[*1], Faseeha Muqadus[2], Laiba Sattar[3], Khush Bukht[4], Moafer Iqbal[5], Muhammad Shaharyar Yaqoob[6], Raza Iqbal[7], Syed Salah Ud Din Umer Khatab Gillani[8]

[*1]*Department of Nutritional Sciences, Government College University, Faisalabad.*
[2]*National Institute of Food Science and Technology, Faculty of Food, Nutrition and Home Sciences, University of Agriculture, Faisalabad, Punjab, Pakistan.*
[3]*Department of Computer Science & IT Superior University 10 km Lahore Road Sargodha, Punjab, Pakistan (40100).*
[4]*M.Phil. Scholar Human Nutrition & Dietetics, Department of Human Nutrition & Dietetics BZU Multan.*
[5]*Department of Biological Sciences, Faculty of Sciences, Superior University, Lahore.*
[6]*Department of Nutrition and Dietetics, The University of Faisalabad.*
[7]*M.Phil. Scholar Computer Science, National College of Business Administration & Economics Multan Campus Multan.*
[8]*Medical Officer, DHQ Teaching Hospital Dera Ismail Khan.*

[*1]dnamnaimran@gmail.com, [2]faseehamuqadus111@gmail.com, [3]laibasattar203@gmail.com, [4]shkkhushi01@gmail.com, [5]moaferiqbal@gmail.com, [6]dietitianshaharyar@gmail.com, [7]ali.raza@bzu.edu.pk, [8]ketogenic.123@gmail.com[8]

DOI: https://doi.org/10.5281/zenodo.15654379

Keywords
Artificial Intelligence (AI), machine learning and deep learning systems, cancer healthcare, lifestyle habits, personalized nutrition suggestions, Anticancer peptides (ACPs), cancer cells, COMBI, ASCAPE, chemotherapy, cationic molecules.

Article History
Received on 06 May 2025
Accepted on 06 June 2025
Published on 13 June 2025

Corresponding Author: *
Amna Imran

Abstract
Patients with cancer need better nutrition and metabolism care to survive and recover because these problems hurt both. These conditions decrease how well treatments work and increase health problems after surgery happens. These problems emerge mainly from inflammation and loss of appetite. What was once impossible in treating cancer patients now becomes possible through artificial intelligence which includes machine learning and deep learning systems. These systems show excellent potential for revolutionizing cancer healthcare. AI uses patient data for accurate diagnosis by modeling outcomes from medical files and visual scans while selecting genetic information. The system analyzes health data from genes, everyday life, and healthcare to understand what and how patients eat then gives individual meal suggestions based on patient needs. Researchers like ACPs more than standard treatment because they destroy cancer cells specifically and create few drug resistance traits. Through our plan this paper demonstrates how AI combined with data analysis can optimize cancer care by creating medicine development methods linked to patient-specific nutrition plans. Artificial Intelligence (AI) changes cancer treatment methods by using data analysis to identify particular genetic factors and medical histories in patients thus producing precise diagnostic conclusions as well as customized treatment procedures. The AI platform COMBI indicates suitable treatments to healthcare providers while ASCAPE showcases enhanced chemotherapy dosing capability

which improves total care effectiveness. Researchers have investigated anticancer peptides (ACPs) as an emerging treatment approach against solid tumors because these peptides use different membrane interaction models to destroy cancer cells without developing resistance. Medical experts lead extensive clinical studies about cationic molecules to research their potential for restricting tumor growth together with their potential to prevent cell migration and blood vessel formation at minimum toxic levels and high precision.

INTRODUCTION

Cancer patients experience negative outcomes in survival duration and recovery because of metabolic and nutritional effects that include malnutrition and sarcopenia and cachexia (Ambrosetti et al., 2020). Weight loss occurs due to anorexia which develops because of inflammation which ultimately results in malnutrition. Cancer patients display this condition frequently since 15 to deaths exist. Weight loss is reported by 40% of patients at cancer diagnosis point (Bozzetti et al., 2009). Medical professionals predict that between forty and eighty percent of patients with cancer will deal with malnutrition as their disease continues to advance. The delivery of treatment can be negatively affected by problems related to nutritional state ("2023 Alzheimer's Disease Facts and Figures," 2023). The healing process of wounds suffers delays and muscle functions degrade while post-surgical complications become more likely. The impact of malnutrition disrupts drug response to antineoplastic treatments and treatment tolerance which leads to patients needing extended hospital time before potentially resulting in survival rate reduction (Radenković et al., 2023). A decrease in lean body mass represents the core sign of sarcopenia whereas decreased physical functioning and reduced strength accompany lean body mass reduction as well as deteriorated quality of life. Medical professionals tend to ignore the diagnosis of sarcopenia because low body mass index measurements fail to identify cancer weight loss in obese patients ("Advances in Geriatrics and Gerontology - Challenges of the New Millennium [Working Title]," 2023). The medical patients who face altered body composition have elevated metabolic risk levels according to research which indicates that they experience more treatment side effects. The illness develops from three interrelated factors resulting in cancer cachexia which represents a multidimensional condition (Kemmler et al., 2020).

The distinct characteristic of this condition involves involuntary continuous loss of weight coupled with skeletal muscle wasting and potentially decreasing fat mass levels which refuse to improve through typical food consumption (Dionyssiotis, 2017). The extensive study on the effects of nutrition on cancer development takes up a significant portion of scientific research. Increasing research shows that nutrition plays a major role in cancer development. The World Cancer Research Fund alongside the American Institute for Cancer Research project that healthy body weight coupled with proper food choices and physical activity helps reduce cancer occurrence by between 30 to 40 percent. Certain types of tumors are likely to demonstrate an even higher risk element than the 30 to 40 percent ("Program," 2022). Researchers have usually investigated single food or nutrient effects on cancer initiation and progression through reductionist methods at designated body sites. Specific disease mechanisms become clearer through the investigatory methods applied to cancer research (Bulletin of the Atomic Scientists, 1958). Such studies alone do not produce a complete understanding of how diet prevents cancer development. The available information is deficient when it comes to dietary recommendations for cancer patients who need nutritional recovery from the disease (Courneya & Friedenreich, 2010).

The current theory of computer system use for artificial intelligence defines it as "the current theory pertaining to the use of computer systems that will make computers capable of performing normal tasks which require human intelligence (Khang, 2023). The capabilities of artificial intelligence system include recognizing voice patterns while simultaneously processing visual information as well as decision making and language translation capabilities and other functions. This article analyzes how artificial intelligence helps treat cancer patients through personalized approaches (Bohr & Memarzadeh, 2020). Daily cancer case numbers have shown an exceptionally enduring rise in recent times. Multiple elements exist which raise the risk of human cancer development. The healthcare industry experienced a revolution through artificial intelligence-based complex disease diagnosis and treatment procedures (Bohr & Memarzadeh, 2020b). The development of individual cancer therapy recommendations through AI applications remains among the most engaging medical applications today. The modern treatment method adapts therapy prescriptions to meet specific patient characteristics and genetic information and past medical records (VanderWalde, 2022).

The application of conceptual algorithms with machine learning strategies and deep learning processes examines and handles nutrition-related datasets encompassing eating patterns together with dietary information and health aspects (Oecd, 2019). Random forests through machine learning algorithms perform the analysis of genetic and nutrition data to study how nutrients affect human genetic variants. Meals are detected while nutritional content assessment is performed through the use of food images analyzed by deep learning models including convolutional neural networks (CNN) and transfer learning pre-trained models(Ciaburro, 2017). The method known as collaborative filtering makes frequent appearances for delivering personalized nutrition suggestions. Treatment of cancer depends wholly on detecting cancer in early stages. Screening techniques supported by artificial intelligence achieve better effectiveness at detecting cancer at its initial stages (Oecd, 2017). Electronic medical health records represent a key technology of artificial intelligence because they maintain a higher dependability than paper records. The main functionality of AI-based personalized therapeutic recommendations depends on analyzing extensive datasets of diverse information (Machine Learning, 2017). Clinical applications of artificial intelligence in oncology depend on three main data types including genetic data extracted through sequencing technology and patient demographics and lifestyle information together with medical history records including treatment histories and diagnostic results. Different data sources integrated within AI systems enable the detection of complex patterns which people would have difficulty interpreting thus producing better customized treatment choices (Medicine et al., 2020). The fundamental role of genomic profiling exists in this strategy. The genetic composition of patient tumors subject to artificial intelligence systems enables the identification of cancer-spreading factors represented by particular mutational patterns. The obtained information serves as a basis for recommending customized treatments including specific drugs for targeting precise genetic abnormalities (VanderWalde, 2022b). By adopting this focused approach, the treatment obtains superior performance while safeguarding patients from unwanted adverse effects. The database functions as an organized framework that detects numerous characteristics related to cancer diagnosis using numerous identifying patterns. Medical health records provide the dual advantage of working simultaneously in different hospital systems (Medicine et al., 2017).

Artificial intelligence saves substantial time and funds because its complete operation depends on software-generated programs. Two supplementary technologies under artificial intelligence are machine learning and deep learning systems. Machine learning defines automated programs in computers which operate independently from immediate training requirements (Oecd, 2019b). Multiple statistical algorithms combined with models enable data analysis in order to produce final conclusions. The deep learning approach represents an artificial intelligence-based system that enables medical professionals to detect and treat human body cancer manifestations (Ranschaert et al., 2019). The analysis of medical image-based data at healthcare facilities serves as an important artificial intelligence-related technology. Multiple medical professionals examine images that high-resolution cameras obtain to detect any pathological aspects (Chen, 2013). Through diagnostic imaging scientists can distinguish cancerous cells from non-cancerous ones since their cellular structures along with functional elements differ extensively. Massive metabolism and reduced functioning identify malignant cells as damaged structures through their dysfunctional measurements (Seyfried, 2012). Malignant cells become larger in dimensions than typical normal cells. Medical imaging procedures rely on these malignant cell characteristics to make their identifications. The usage of artificial intelligence systems in cancer medicine provides multiple benefits by delivering precise data analysis and decrease errors rates. The practice benefits patients through computer-based technology applications which deliver higher standards of healthcare (Kulski, 2016). Artificial intelligence technology reduces the expenses associated with medical care. The system delves into easy administration access coupled with real-time accurate data provision while it minimizes employee stress. User-friendly software connectivity enables medical personnel to integrate AI-derived knowledge directly into their clinical decision-formation process (Medicine, Medicine, et al., 2020). The junction of human experience together with AI abilities forms a powerful blend that provides the most personalized and high-quality healthcare treatment results. Artificial intelligence combines adjustment of medical treatments with examination of clinical information, genetic profiles and personal values and patient preferences within healthcare decisions. The method finds optimal treatment solutions by matching recommendations to individual patient goals because it respects patient-centered healthcare principles (VanderWalde, 2022c). Patient activation and involvement becomes stronger because of this caring approach to patients. Technology's operations occur at a rapid pace compared to human resources which simplifies the process of identifying cancer. The method provides scientists with the ability to detect both the genetic nature of cancer in addition to its initiating factors and resulting effects. The medical field currently develops artificial intelligence-based tests for cancer detection before any symptoms materialize (Schulte & Perera, 2012). Artificial intelligence has achieved one of its landmark accomplishments through cancer genomics which involves studying DNA sequences that lead to body cancer development. DNA alterations together with chromosome changes enable this method to differentiate between cancer cells and healthy cells. This technique permits scientists to determine which carcinogens trigger human cancer by targeting particular body regions. Air pollution contains various carcinogens that strike the lungs to cause lung cancer (Bass & Birchler, 2011).

The main cancer risk elements consist of unhealthy life choices and domestic inactivity and environmental toxins and excessive drinking and smoking habits. The current most powerful therapeutic options against cancer consist of chemotherapy coupled with radiation therapy with surgical intervention and their possible combination treatments (Reuben, 2010). The effectiveness of these treatments faces multiple obstacles which act as restrictions. Drug resistance presents as the leading reason why chemotherapeutic medicines become less effective. Tumor cell metabolic heterogeneity functions as a main factor for medication resistance due to several tissue-level and cellular-based resistance mechanisms (Teicher, 2007). Multiple tumor cell types with similar metabolic characteristics create a resistance to chemotherapy treatment that propagates cancer cell spread. Drug transporters that are overexpressed together with growth signaling pathway modifications and disruptive apoptotic pathways and anomalous DNA damage repair capability are universal cellular mechanisms which enable cancer cells to develop drug resistance (Di Fagagna et al., 2007). The current cancer therapy approaches demonstrate inefficient results yet anticancer peptides show potential to replace these traditional methods according to research. The antimicrobial antitumor peptides (ACPs) display both antimicrobial and anticancer activities (Honecker & Dyshlovoy, 2018). Anticancer peptides are a group of short cationic molecules composed of five to fifty amino acids. ACPs display different formats in their structure because Triptycene and Indolizidine possess extended linear arrangements while β-sheet folding characterizes Defensins and Lactoferrin and α-helices occur in LL-37 and BMAP-27 and BMAP-28 as well as Cecropin A. Cancer cells exhibit different features than regular cells because they possess microvilli structures on their external cell wall together with high membrane flexibility and negative membrane surface charge (Baba & Cătoi, 2007). ACP molecules induce cancer cell necrosis though electrostatic bond formation between their positive charge and cancer cell membranes carrying negative charge. The potential anticancer properties of ACPs exist through known mechanisms including apoptosis initiation via mitochondrial membrane rupture as well as angiogenesis pathway obstruction and immune cell activation to destroy cancer cells (Mogk et al., 2022). Active cancer peptides stimulate the pore development process while simultaneously activating important proteins that end in cancer cell destruction. A graphical illustration in Fig. 1 describes how ACP executes its functional activities. The major advantage of using ACPs as anticancer agents comes from their ability to produce limited drug resistance (Gene Therapy - Principles and Challenges, 2015).

Some ACPs demonstrate a capability to transmit cancer medications through cell membranes to strengthen drug penetration thus optimizing therapeutic results. The medical field is testing multiple synthetic as well as naturally occurring peptides for possible anticancer use (Otvos, 2008). Natural peptides suffer from decreased sensitivity and stability compared to synthetic ACPs according to. The useful natural peptides generally display α-helical structures that exhibit cationic characteristics among other structural patterns that include fold patterns and anionic features (El-Sharoud, 2007). A peptide originating from Lentinus squarrosulus mushrooms shows the ability to trigger apoptosis in cells of human lung cancer. This review analyzes the importance of AI alongside nutrition in cancer treatment as well as explaining the mechanisms behind anti-cancer drugs or peptides (Grumezescu & Holban, 2017).

DEFINITIONS OF NUTRITION AND CANCER:

Through **nutrition** living organisms obtain food constituents which enable them to grow develop and maintain their processes of reproduction. Every creature on Earth needs food to fulfill several biological needs (Molecular Biology of the Cell, 2002). All organism functions depend on energized materials that nutrition provides which enables cell component synthesis as well as movement along with essential waste elimination and nutrient absorption throughout the organism. The live cell requires food components to build its structural and catalytic elements in addition to supplying necessary building blocks (Marschner, 1995). Living organisms differ in terms of the specific food compounds they need together with their methods of food synthesis and their cellular nutritional requirements. Scientists can identify common patterns regarding the life-sustaining nutrients along with feeding processes in all living systems (Fowler et al., 2023). Some cellular precursors can be produced by the cell from its materials but the precursors that cells need through diet are known as **nutrients** (Anderson et al., 2014). All inorganic substances required for growth belong to this category along with various organic chemicals which may number from one to thirty or more based on the particular organism. The ability of organisms to synthesize nonessential nutrients does not stop them from using the available food nutrients if those are present because this conserves their energy for synthesis (Molecular Biology of the Cell, 2002b).

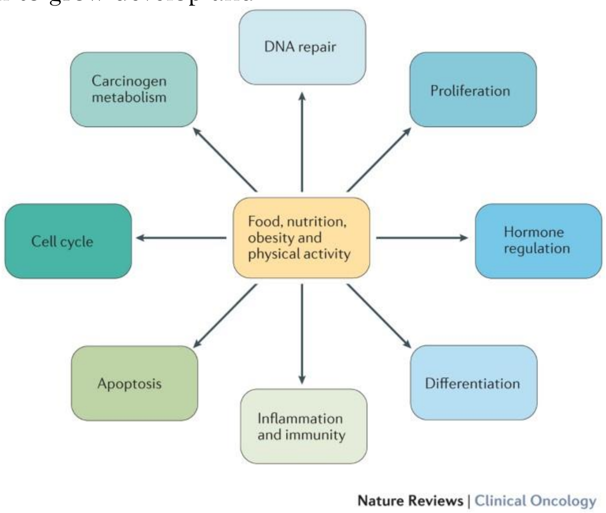

Figure.1 Food, nutrition, obesity, physical activity, and the cellular processes linked to cancer

Cancer is a condition represents a wide group of disorders because it causes normal cells to transform into **cancerous cells** before their uncontrolled growth and spread throughout the body. Cancer represents a medical group which includes problematic cell multiplication leading to body tissue propagation (Eggert, 2010). Benign tumors prove non-invasive because they fail to disseminate throughout the body tissues. Different possible symptoms include having a lump while bleeding irregularly alongside a persistent cough and weight loss without reason or changes in bowel movements (Baba & Cătoi, 2007b). There are alternative explanations for these symptoms even though cancer could potentially be the reason. More than 100 distinct cancers afflict human beings.

Some cancer types become less likely when people quit smoking and maintain fitness levels and drink alcohol in moderation while eating plenty of fruits and vegetables with whole grains and getting vaccinated against infectious diseases together with reducing their red meat and processed meat consumption and shielding themselves from sunlight (Mahmoudi & Rezaei, 2019). Cervical and colorectal cancers remain detectable during early stages through screening procedures. Health professionals disagree about whether breast cancer screening delivers any benefits (Council et al., 2003). The treatment of cancer combines different approaches which mainly include radiation therapy with surgery and chemotherapy followed by targeted therapy according to patient needs. Some cancer immunotherapy developments provide customized treatments which let patients utilize their immune systems for treatment (VanderWalde, 2022d). Symptom and pain management stands as a crucial element in providing patient care. Medical professionals should prioritize palliative care treatments specifically for patients in advanced stages of illness. A patient's cancer type together with their initial disease severity will establish their chances of survival (Ferrell, 2016).

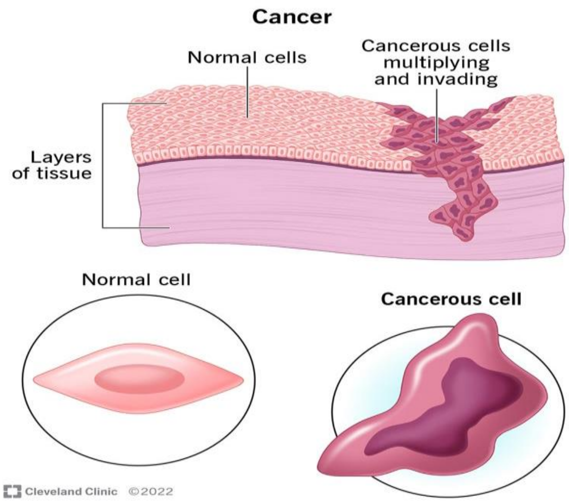

Figure.2: Normal cells become cancerous cells that multiply and spread and cause cancer

AI IN THE MEDICAL FIELD:

The examination and presentation of difficult health and medical care data by software through machine-learning algorithms describes how artificial intelligence functions in healthcare systems (VGeetha, 2024). Healthcare AI applications function to find relationships between healthcare results and medical treatment practices. Artificial Intelligence stands apart from conventional methods through its dual ability to gather data as well as process it and interpret the results and generate a specific output (Ranschaert et al., 2019b). The integration of deep learning methods with machine learning techniques allows AI to function this way. The automated systems detect behavioral sequences while producing their own analytical outcomes. Medical institutions apply AI-based information technology to operate in diagnostic medicine as well as develop drugs and customize treatments while detecting patient conditions and establishing treatment guidelines (Higgs et al., 2008).

Healthcare professionals employ this technology to identify and rate the risk factors in patients who suffer from "coronary artery disease." Artificial intelligence algorithms show promise for early triage of coronary artery disease through their diagnostic capabilities (Holley & Becker, 2021). In addition, AI technology supports various aspects of gastroenterology medical practice. Endoscopic tests that incorporate colonoscopies and esophagogastroduodenoscopies depend on swift tissue abnormalities detection abilities (Greenspan, 2017). The medical community now predicts that artificial intelligence integration will improve endoscopic procedures by enabling practitioners to detect diseases along with determining their severity and seeing previously hidden areas promptly (Hashimoto et al., 2021). AI technology shows exceptional promise in clinical and laboratory environments of “infectious disease medicine” while emerging as the United States invests over $2 billion into AI-linked research studies by 2025 which doubles the 2019 expenditures of $463 million (Engineeri et al., 2022). The implementation of AI-based Neural networks enables precise and speedy tracking of Coronavirus host responses using mass spectrometry samples. Current applications of AI in infectious diseases involve support-vector machines to determine antibiotic resistance and ML-based blood smear evaluation for malaria diagnosis together with advanced point-of-care Lyme disease diagnostics through antigen detection (Hamdan et al., 2021). AI researchers conducted studies to improve tuberculosis and meningitis and sepsis diagnosis while developing predictions for treatment issues in hepatitis C and B patients.

AI IN CANCER PREDICTION:

Multiple disciplines of carers, including specialists and paramedics have engaged in cancer prognosis predictions by utilizing their professional expertise since the previous decades (Atlanta, 2004). Medical professionals recognize that artificial intelligence technologies need implementation in the digital data era because statistical analysis requires deep learning and machine learning methods (Bohr & Memarzadeh, 2020d). The apprehension level of healthcare professionals concerning patient disease acquisition stands at six professionals while six others fear patients will experience tumor recurrence or death following treatment (Lexicon of Psychiatric and Mental Health Terms, 1994). These factors significantly impact therapy options and outcomes. Clinically-based oncology research concentrates on two things: predicting how patients will react to therapy and making prognosis predictions. More accurate prognoses enable patients to access better treatment methods which commonly use personalized or individualized care delivery for each patient (VanderWalde, 2022e). AI systems review comprehensive medical data patterns during healthcare assessments to deliver precise predictions regarding patient survival rates and disease evolution in cancer patients. 9 Enshaei et al. explored various clinician-assisted approaches that verified AI can enhance diagnostic and forecasting capabilities for ovarian cancer patients (Dubey et al., 2021).

Artificial intelligence systems demonstrate their capability to process unstructured data which leads to precise assessments of disease development probabilities including cancer. Artificial-neutral AI systems improve risk segmentation criteria that affects which patients receive cancer screening (Ranschaert et al., 2019c). The artificial neural network model for colorectal cancer risk stratification provided better accuracy than traditional screening guidelines according to research by forty-eight to fifty-two subjects (Koulaouzidis & Marlicz, 2021).

The AI algorithms enable application to every member of a population group. The algorithms support two groups of people who face increased cancer risk along with patients who do not meet screening eligibility criteria. Risk-based screening criteria enable patients with "early-onset sporadic colorectal cancer" to receive potential benefits although conventional screening methods have restrictions (Bohr & Memarzadeh, 2020e).

Personal risk assessments of tumors that presently have no specific screening method and which usually show no symptoms during early development could enhance both detection timeliness and therapy success rates (Council et al., 2003b).

APPLICATION OF AI, ML, AND DL IN NUTRITION:

The authors organized the theoretical framework based on the five derived clusters of study items about AI, ML and DL use within nutrition research. The research presents a conceptual model where AI and ML techniques combined with DL methods operate throughout the entire nutrition system to reach optimal individualized medical results (Oecd, 2019c). The outlined methods span all accepted content analysis procedures although they represent more than traditional approaches. Each series of significant reference techniques and instruments linked to the research led to acquired results by the study team (Bulletin of the Atomic Scientists, 1955). A proximate opportunity generated a relationship between the clusters to establish an all-encompassing and efficient AI-assisted nutrition system. The proposed framework shows how AI can serve personal nutrition through multiple connected components in a complex system for management purposes (Council et al., 2015). We commence with user input. People must include personal background data combined with health records, their food habits and physical movement patterns along with any health problems that need monitoring. The obtained information enables the system to function. The system uses multiple AI technologies to progress into different applications which enable customized nourishment delivery (Bulletin of the Atomic Scientists, 1972).

The system delivers suitable personalized nutritional advice to users with the goal of promoting their wellbeing. A database entry of basic user information serves as a mandatory input for dietary assessment execution (I. O. Medicine et al., 2003). The received user input enables dietary assessment procedures that evaluate food and drink consumption over a specific period to verify they satisfy nutritional guidelines and user targets. The project uses CNN-based algorithms combined with transfer learning technology that applies pre-trained models such as ResNet and Inception for exact food identification (Bohr & Memarzadeh, 2020f). Machine learning enables the administration of databases and data through its techniques. Dietary information which comes from meal diaries and dietary surveys and wearable devices reveals user nutritional patterns. Post the evaluation of user targets and dietary guidelines software solutions improve user food recognition capabilities while offering them fast nutritional assessment capabilities (Nations, 2013). The detection techniques of object detection help vision-based algorithms analyze large food image databases to classify and identify various meals from their pictures. CNNs together with YOLO and Faster R-CNN serve as advanced object identification models which perform real-time food recognition along with tracking (Cremers et al., 2015).

The tracking method combines data from food images and wearable cameras and logging applications to provide automatic precise food consumption monitoring which enables proper dietary management for users (Sazonov, 2018). Food recognition delivers its best outcomes after dietary assessment since it reinforces user food selection choices by considering user expectations and requirements following evaluation. The application of AI methodologies serves patients with specific medical diseases to create predictive models and identify diseases and track their conditions (Bagchi, 2014). By implementing AI technology scientists aim to control human body diseases while focusing on dietary aspects. AI systems detect disease risk directions through the combination of patient medical records with genetic factors along with daily life data. The latest machine learning algorithms which include random forest alongside support vector machines and gradient boosting as well as ensemble learning operate for disease risk prediction (Bohr & Memarzadeh, 2020g). Health management systems using this approach enable patients to detect health issues early and forecast their potential development. The value of correct dietary evaluation combined with health risks from nutritional intake will help AI systems generate personalized dietary plans for well-being (*Popular Science*, 2005). Recommendations designed for individual users address their dietary restrictions together with their specific requirements. The generation of personalized suggestions uses algorithms that include collaborative and content-based approaches and hybrid techniques in combination with deep learning NLP and RL processes for chatbots along with NGS for thorough genetic evaluation (Bhanu & Kumar, 2018). The random forest models together with XGBoost technology improve the process of delivering customized nutritional guidance to users. Personalised meal planning beneficiaries from three algorithms including genetic algorithms and particle swarm optimization and restricted programming (Kotu & Deshpande, 2014).

Our system finishes its operation by suggesting personalized nutritional advice while assessing life changes through mobile programs and wearable devices and scheduled report distribution. People using AI-driven nutritional solutions throughout the day help achieve important behavioral changes to establish long-lasting eating habits (*Working Mother*, 2000). The incorporation of AI, ML and DL applications in this domain relies on behavioral patterns for creating individualized intervention programs that deliver specific techniques which adapt to maintain positive health outcomes throughout time (Rana et al., 2019). User interactions with the system as well as disease data updates create a feedback process that leads to improved AI model development for individualized nutritional solutions. This entire system aims to create personalized diet goals while offering advanced monitoring tools alongside complete health objective achievement (Oecd, 2019d). The clusters function autonomously as a whole method that uses advanced artificial intelligence technologies to create breakthroughs in individual nutrient optimization.

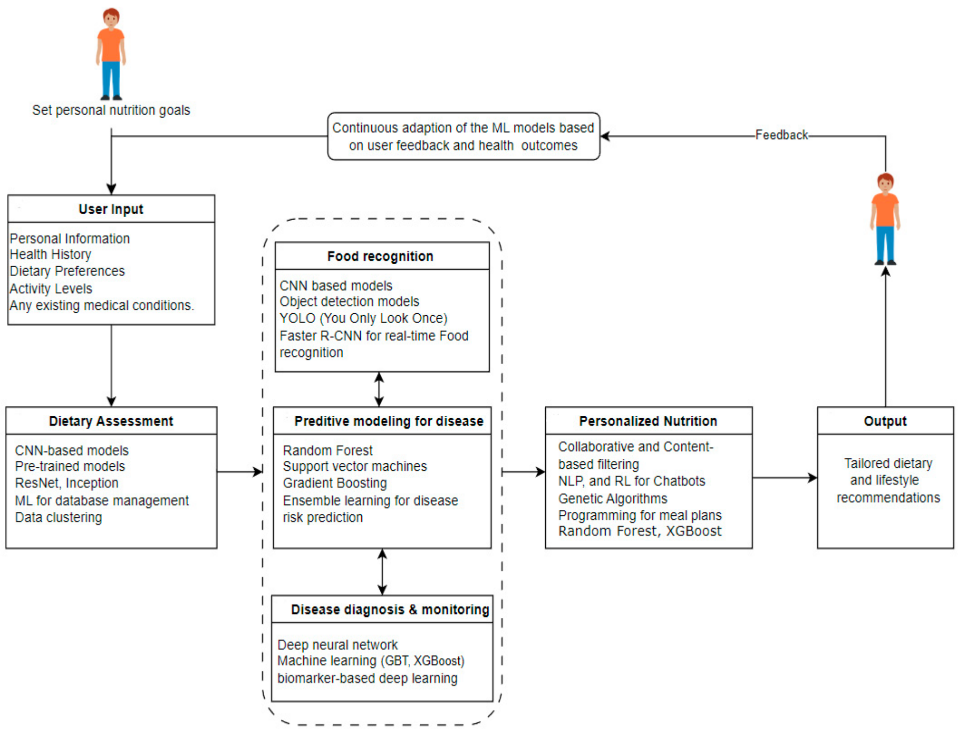

Figure 3. Proposed conceptual framework for AI, ML, and DL applications in nutrition.

AI-BASED RECOMMENDATIONS FOR CANCER PATIENTS DURING TREATMENT:

Artificial Intelligence functions as human simulation technology which converts raw data into significant information for decision making purposes. The deep learning computer-aided algorithms function to convert raw data into information which supports treatment decision-making. Modern methods have been developed to predict cancer development (Nayak et al., 2021). Artificial Intelligence (AI) employs sophisticated computer systems for the prediction and detection of cancer. Both art and artificial intelligence systems have accomplished extensive changes in how medical professionals approach cancer problems (C. E. B. a. E. D. T. P. D. B. K. D. N. P. D. M. D. D. a. K. VGeetha, 2024). The medical detection systems of Artificial Intelligence (AI) help to identify cancer with high accuracy during early diagnosis stages. The future-oriented technology provides a speedy system for detecting and predicting malignant cells. Health organizations view cancer as a top health menace that leads to numerous deaths each year across the world (Bohr & Memarzadeh, 2020h). Failure to detect cancer at its early stages makes life threatened by the disease regardless of its specific type. The survival rates for patients become higher with an early detection of cancer. Artificial intelligence has brought about revolutionary advances in both detecting cases of cancer and treating these patients. New artificial intelligence-based computer-aided solutions function as the main tools for patient monitoring management systems (*Popular Mechanics*, 2000).

AI technology operates beyond prediction tasks for personalized care of cancer patients. Through its risk evaluation process the system analyzes every potential disadvantage as well as post-implementation effects of the various therapeutic choices (Bohr & Memarzadeh, 2020i). The analysis completely reviews both the patient's general medical condition and active diseases and all possible elements which influence the acceptance and suitability of selected treatments. Healthcare professionals keep an essential position during the growing dominance of AI in medical environments (N. a. O. S. E. A. Medicine et al., 2018). The beneficial advice and insightful input of artificial intelligence (AI) exists as a teamwork tool instead of replacing expert medical practice. Oncologists together with AI incorporate their medical experience along with patient-centered practices to produce treatment suggestions that address individual patient worth and health objectives (N. a. O. S. E. A. Medicine, Medicine, et al., 2020b). Standard procedures require oncologists to provide medications that doctors have prescribed to patients. The overall treatment success decreases when this approach is used. Using advanced artificial intelligence technology CURATE operates autonomously as an efficacy-focused mechanism to deliver chemotherapy medications through a separate administrative method (N. a. O. S. E. A. Medicine, Division, Services, & Forum, 2018).

The treatments given to cancer patients adjust to accommodate their specific health requirements. Professionals should use customized dosage adjustments to provide care to their patients. Phase - 1 patients experience a decision between drug toxicity levels and drug effectiveness levels (Bernicker, 2019). The medical industry underwent substantial change after the implementation of artificial intelligence (AI) together with precision medicine. Healthcare Artificial Intelligence advances at higher speed because of medical data digitalization processes. Better security coupled with strengthened privacy benefits through Artificial Intelligence enables full access to patient medical records (Adebayo et al., 2022). Precision or personalized medicine stands as an approach to provide individualized healthcare solutions specifically for patients who present particular health conditions. The necessary information must come from genetic data and physiological readings instead of medical records. Individualized treatment plans remain in place for each patient through this system to provide them with proper healthcare (Bellazzi et al., 2016). During patient treatment clinicians need to determine both the therapy approach that suits the situation and how that approach should function. Patient treatment becomes increasingly challenging because each person shows different responses to medical tests throughout time (Perk et al., 2012).

The situation grows more complex as multiple medications extend their duration of combined use. Each phase of medical provision brought about an evolution in how a particular patient reacts to treatment. Research needs have increased to study and interpret the extensive amount of collected time-series data resulting from extensive data generation techniques (Gatt et al., 2009). Huge data synthesis relies on various statistical methods which AI applies to develop personalized medical treatments specifically for individual patients. Medical oncology has made substantial changes over time in response to developing medical procedures (Sai et al., 2024). Through Artificial Intelligence medical professionals now provide exact diagnosis methods for their patients. Artificial Intelligence-based medical devices introduced a unique operational capability to help patients obtain healthcare solutions. The persistent nature of cancer requiring advanced levels of patient medical care (Kumar et al., 2022).

Toxicity from the healthcare treatment causes substantial deterioration in patient quality of life. People consume drugs according to procedures determined by medical specialists but the populace does not have any options for alternative administration methods ("Geriatric Medicine and Healthy Aging," 2022). New techniques in data science along with artificial intelligence technologies improve both health results while assisting in cancer patient care management. Multiple aspects of life experience deterioration as a result of breast cancer (Jamshidi et al., 2020). ASCAPE functions as a platform which releases artificial intelligence techniques for breast cancer therapy. Multiple interventions have been suggested by the physician for delivering modern medical treatments to patients (N. a. O. S. E. A. Medicine et al., 2020). The computer-based Artificial Intelligence technology requires human intelligence to complete its specific operations. The complete technology operates as a platform to support applications while affecting both communities and commercial systems. The generation of medical imaging for cancer detection and treatment facilitates precision medicine for each patient (Bui & Taira, 2009).

Due to advances in Artificial Intelligence technology the delivery of computer-aided diagnosis and detection capabilities has gained nationwide accessibility through initial worker integration. Artificial intelligence (AI) operates through peripheral intelligence together with large data technology as its core operational elements (Bank, 2020). The evolving state of therapy made oncologists prefer specific patient care approaches. Every patient requires specific medications and therapies which need to be identified as individualized plans. The rise of Artificial Intelligence in the market resulted in breakthrough success in personalized healthcare delivery. Artificial Intelligence through computational modeling produced management models for healthcare patients with specific needs (Bohr & Memarzadeh, 2020j). The integrated modeling system allows medical staff to support their patients. The therapeutic procedures used for cancer patients in Russian healthcare programs experienced major structural changes. Artificial Intelligence has brought major changes in the way universal fit strategies previously operated (*Popular Mechanics*, 2000b). Medical professionals have analyzed both genetic data and lifestyle factors of patients to determine disease solutions. Throughout time clinicians have faced rising challenges with patient manual evaluation that led to the requirement of a new Artificial Intelligence method for solving these difficulties. Cancer led to approximately 600,000 American deaths in the country during 2022. Detection of malignancy represents the primary health concern at present (Bohr & Memarzadeh, 2020k)

ACPs (ANTI-CANCER PEPTIDES):

Molecular biology research techniques have shown that multiple small peptides exist throughout different living creatures according to. The peptides demonstrate multiple destructive effects against bacteria and fungus and cancer cells and immune system regulation properties (*Ion Channel Factsbook*, 1995). Anti-tumor properties characterize cationic low-molecular-weight peptides which scientists have identified through combining structural and functional data research. The antibacterial property evaluation of peptides from multiple biological sources eventually led to their designation as anti-cancer medications in 1985 (Otvos, 2008b). Due to their unique mechanism of action ACPs demonstrate better advantages than conventional chemotherapy because they block tumor cell proliferation while also halting cell migration and stopping tumor angiogenesis. The advanced solid-phase synthesis allows them to be produced at low-cost while being easily customizable (Padmanabhan et al., 2020).

The potential therapeutic value of ACPs seems promising because these compounds penetrate tissue efficiently while triggering drug resistance in few cases. The US National Institutes of Health Clinical Trials database (https://clinicaltrials.gov/) showcased 1002 ongoing peptide-based clinical trials which targeted different types of cancer through the search term 'anti-cancer peptides (Absolom & Struys, 2019). The anti-tumor properties of Bryostatin 1 have become established through Phase I studies among patients with malignant melanoma and lymphoma as well as ovarian cancer. During Phase I clinical studies

Aplidine (plitidepsin) maintained good tolerability levels and Phase I studies established its low toxicity profile (Rahman et al., 2018). Currently researchers conduct Phase II evaluation of these products. Medical trials using Aplidine for treat patients with advanced medullary thyroid carcinoma, advanced malignant melanoma and small cell lung cancer entered their Phase II stage (Bhakuni & Rawat, 2006). lung cancer and advanced renal cell carcinoma. The FDA together with EMA granted approval to over twenty ACPs during November 2019. The medical industry received four new ACPs including Kyprolis and Soma Kit TOC and Lukather and Gallium Dotatoc Ga68 within the year. The group of ACPs establishes itself as an encouraging remedy system beyond conventional chemotherapy treatments. Many ACPs suffer from reduced effectiveness because they have both substantial toxicity properties and insufficient targeting mechanisms (Patel et al., 2016).

MECHANISM OF ACPs (ANTICANCER PEPTIDES) FOR CANCER TREATMENT:

Traditional anticancer medications primarily target specific macromolecules, but the majority of cationic antimicrobial peptides (ACPs) interact with cancer cell membranes which results in cellular lysis and eventual demise (Otvos, 2008c). The innovative mechanism of action offered by ACPs enables developers to make new cancer drugs that work separately from traditional anticancer medications while staying beyond the reach of cancer cell resistance mechanisms (Hayward, 2010).

Membrane-disruption functionality of antimicrobial peptides (ACPs) depends on a range of physicochemical elements such as peptide sequence along with net positive charge and hydrophobicity as well as structural conformations of secondary structure and dynamics and orientation within membranes and the capability for self-assembly and peptide concentration and cellular membrane composition (Tsai, 2007). Researchers presently discuss three fundamental mechanisms for understanding antimicrobial peptide (ACPs) membrane disruption behavior which include the carpet model together with the barrel-stave model and finally the toroidal-pore wormhole model.

Electrostatic attraction forces between antimicrobial cationic peptides (ACPs) and negatively charged phospholipids within the outer membrane layer cause parallel ACP orientation that forms a carpet structure encasing the cell without bilayer lipid integration (Weller, 2011). When the peptide concentration reaches the critical threshold, these molecules will experience structural changes through a spin mechanism before they integrate into membranes and form micellar aggregates by utilizing hydrophobic forces that result in membrane destruction (*Molecular Biology of the Cell*, 2002c).

Antimicrobial peptides attach to the cell membrane through physical interactions by binding with their hydrophilic segments during the initial phase of the barrel-stave model. When the peptide monomer experiences structural change, it self-assembles supramolecularly to produce transmembrane channels and stave-like structures inside the lipid bilayer (Katsaras & Gutberlet, 2013). The bilayer forms a hydrophilic channel after peptide insertion while moving its hydrophobic parts away. The channel creation enables fresh peptide molecules to enter which enlarges its dimensions. Cancer cell membrane integrity suffers damage as a result of physical contacts established by ACPs (Lambert & Mastrangeli, 2019). The known antimicrobial peptide (ACP) that eliminates cancer cells through barrel stave model operation is alamethicin which was identified until this present time.

The toroidal pore model describes two different interaction pathways which antimicrobial peptides (ACPs) establish with cellular membranes. The peptide maintains an inactive state when low doses exist but it orients itself in parallel to the membrane bilayer (Albericio, 2020). As the concentration reaches specified levels the peptide transforms into its active state through perpendicular insertion which leads to irreversible membrane destruction through toroidal pore formation. One hundred four the produced toroidal pore facilitates the influx of more ACPs into the cell's intracellular environment. The disruption of cell membranes by numerous antimicrobial peptides (ACPs) occurs through their use of the toroidal pore mechanism which includes cecropin A, protegrin-1, and magainin-2 (Aird, 2020).

CONCLUSION:

The combination of malnutrition alongside sarcopenia and cachexia typically affects cancer patients and severely decreases their treatment outcomes and duration of survival. Weight loss, inflammation, and poor nutrient absorption regularly happen to patients which causes longer healing time while raising the possibility of complications. Artificial Intelligence (AI) advances cancer care delivery through its capability to detect cancer early while generating personalized medicine and supplying superior nutrition assistance to patients. AI systems construct unique care plans by analyzing big data collections that include patient genetics besides medical information and food choices. Technologies such as machine learning and deep learning power tools for food recognition, dietary assessments, and disease monitoring. Medical practitioners strengthen both testing precision and therapeutic strategies through AI and diminish hospital expenses while lowering error rates. The identification of cancer risks together with outcome predictions and clinical decision support are activities in which this system mainly operates. Alternative cancer therapy utilizing anticancer peptides (ACPs) proves attractive because they attack cancer cells specifically without creating traditional chemotherapy-resistance. These peptides destroy cancer cells through mechanisms like membrane disruption and immune activation. AI applications with advanced nutrition science and anticancer peptides compose a comprehensive disease management strategy which enhances patient results while bringing better quality care to life. The field of cancer treatment currently experiences a transformation through Artificial Intelligence (AI) which triggers early diagnostic capabilities as well as individual therapy solutions and enhanced medical care for patients. Patient data evaluation through artificial intelligence enables medical professionals to rely on genetic and historical information for treatment adjustments which enhance therapeutic results specifically in chemotherapy interventions. The tools named CURATE and ASCAPE depend on AI technology for delivering individualized care that achieves precision accuracy. The development of anticancer peptides (ACPs) provides medical communities with new possibilities for treating cancer conditions apart from conventional therapeutic options. The small positively charged peptides use membrane disruption mechanisms such as carpet model and barrel-stave model and toroidal pore formation to destroy cancer cells. The drug combination between ACPs delivers two main advantages including decreased side effects and limited drug resistance. Several anticancer peptide drugs undergo clinical trials while certain formulations have received approval for patient use. AI combined with ACPs presents a promising path to deliver specific cancer treatment that helps both patients and their care process.

REFERENCES:

2023 Alzheimer's disease facts and figures. (2023). Alzheimer S & Dementia, 19(4), 1598–1695. https://doi.org/10.1002/alz.13016

Absolom, A., & Struys, M. (2019). An overview of TCI and TIVA. Lannoo Publishers.

Adebayo, O., Aldoori, J., Allum, W., Aruparayil, N., Badran, A., Beatty, J. W., Bhatia, S., Bolton, W., Giwa-Brown, L., Burke, J., Carr, H. J., Chae, Y., Clements, J., El-Sayed, C., Foster, W., Gall, T., George, M., Guest, F., Haq, M., . . . Price, R. (2022). Future of Surgery: Technology Enhanced Surgical Training: Report of the FOS:TEST Commission. https://doi.org/10.1308/fos2.2022

Advances in Geriatrics and Gerontology - Challenges of the New Millennium [Working title]. (2023). In IntechOpen eBooks. https://doi.org/10.5772/intechopen.111024

Aird, S. D. (2020). Identification and functional characterization of novel venom components. MDPI.

Albericio, F. (2020). Chemical synthesis of peptides. Wiley.

Ambrosetti, M., Abreu, A., Corrà, U., Davos, C. H., Hansen, D., Frederix, I., Iliou, M. C., Pedretti, R. F. E., Schmid, J., Vigorito, C., Voller, H., Wilhelm, M., Piepoli, M. F., Bjarnason-Wehrens, B., Berger, T., Cohen-Solal, A., Cornelissen, V., Dendale, P., Doehner, W., . . . Zwisler, A. O. (2020). Secondary prevention through comprehensive cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. European Journal of Preventive Cardiology, 28(5), 460–495. https://doi.org/10.1177/2047487320913379

Anderson, J., Root, M., & Garner, S. (2014). Human nutrition: Healthy Options for Life. Jones & Bartlett Publishers. Atlanta. (2004).

Baba, A. I., & Cătoi, C. (2007a). Comparative Oncology.

Baba, A. I., & Cătoi, C. (2007b). Comparative Oncology.

Bagchi, D. (2014). Nutraceutical and functional food regulations in the United States and around the world. Elsevier.

Bank, A. D. (2020). Innovate Indonesia: Unlocking Growth Through Technological Transformation.

Bass, H., & Birchler, J. A. (2011). Plant cytogenetics: Genome Structure and Chromosome Function. Springer Science & Business Media.

Bellazzi, R., De Quiros, F. G. B., Koch, S., Kulikowski, C., Lovell, N., Maojo, V., Park, H., Sanz, F., Sarkar, I., Tanaka, H., & Al-Shorbaji, N. (2016). Discussion of "The New Role of Biomedical Informatics in the Age of Digital Medicine." Methods of Information in Medicine, 55(05), 403–421. https://doi.org/10.3414/me15-12-0005

Bernicker, E. H. (2019). Cancer and society: A Multidisciplinary Assessment and Strategies for Action. Springer.

Bhakuni, D. S., & Rawat, D. (2006). Bioactive marine natural products. Springer Science & Business Media.

Bhanu, B., & Kumar, A. (2018). Deep learning for biometrics. Springer.

Bohr, A., & Memarzadeh, K. (2020a). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020b). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020c). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020d). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020e). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020f). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020g). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020h). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020i). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020j). Artificial intelligence in healthcare. Academic Press.

Bohr, A., & Memarzadeh, K. (2020k). Artificial intelligence in healthcare. Academic Press.

Bozzetti, F., Arends, J., Lundholm, K., Micklewright, A., Zurcher, G., & Muscaritoli, M. (2009). ESPEN Guidelines on Parenteral Nutrition: Non-surgical oncology. Clinical Nutrition, 28(4), 445–454. https://doi.org/10.1016/j.clnu.2009.04.011

Bui, A. A., & Taira, R. K. (2009). Medical Imaging Informatics. Springer Science & Business Media.

Bulletin of the Atomic Scientists. (1955).

Bulletin of the Atomic Scientists. (1958).

Bulletin of the Atomic Scientists. (1972).

Chen, C. (2013). Computer vision in medical imaging. World Scientific.

Ciaburro, G. (2017). MATLAB for machine learning. Packt Publishing Ltd.

Council, N. R., Medicine, I. O., & Board, N. C. P. (2003a). Fulfilling the potential of cancer prevention and early detection. National Academies Press.

Council, N. R., Medicine, I. O., & Board, N. C. P. (2003b). Fulfilling the potential of cancer prevention and early detection. National Academies Press.

Council, N. R., Medicine, I. O., Families, B. O. C. Y. A., & Success, C. O. T. S. O. C. B. T. a. 8. D. a. B. T. F. F. (2015). Transforming the workforce for children birth through age 8: A Unifying Foundation. National Academies Press.

Courneya, K. S., & Friedenreich, C. M. (2010). Physical activity and cancer. Springer Science & Business Media.

Cremers, D., Reid, I., Saito, H., & Yang, M. (2015). Computer Vision – ACCV 2014: 12th Asian Conference on Computer Vision, Singapore, Singapore, November 1-5, 2014, Revised Selected Papers, Part II.

Di Fagagna, F. D., Chiocca, S., McBlane, F., & Cavallaro, U. (2007). Advances in molecular oncology. Springer Science & Business Media.

Dionyssiotis, Y. (2017). Frailty and sarcopenia: Onset, Development and Clinical Challenges. BoD – Books on Demand.

Dubey, H. M., Pandit, M., Srivastava, L., & Panigrahi, B. K. (2021). Artificial intelligence and sustainable computing: Proceedings of ICSISCET 2020. Springer Nature.

Eggert, J. (2010). Cancer Basics.

El-Sharoud, W. (2007). Bacterial physiology: A Molecular Approach. Springer Science & Business Media.

Engineeri, N. a. O. S., Medicine, N. a. O. S. E. A., Division, H. a. M., He, B. O. P. H. a. P., Practice, B. O. P. H. a. P. H., & States, C. O. T. L. H. a. E. E. O. a. R. I. T. U. (2022). Combating antimicrobial resistance and protecting the miracle of modern medicine. National Academies Press.

Ferrell, B. (2016). Pediatric Palliative care.

Fowler, S., Roush, R., & Wise, J. (2023). Concepts of biology.

Gatt, A., Portet, F., Reiter, E., Hunter, J., Mahamood, S., Moncur, W., & Sripada, S. (2009). From data to text in the Neonatal Intensive Care Unit: Using NLG technology for decision support and information management. AI Communications, 22(3), 153–186. https://doi.org/10.3233/aic-2009-0453

Gene therapy - principles and challenges. (2015).

Geriatric medicine and healthy aging. (2022). In IntechOpen eBooks. https://doi.org/10.5772/intechopen.98018

Greenspan, P. B. (2017). The diagnosis and management of the acute abdomen in pregnancy. Springer.

Grumezescu, A. M., & Holban, A. M. (2017). Therapeutic foods. Academic Press.

Hamdan, A., Hassanien, A. E., Khamis, R., Alareeni, B., Razzaque, A., & Awwad, B. (2021). Applications of artificial intelligence in business, education and healthcare. Springer Nature.

Hashimoto, D. A., Rosman, G., & Meireles, O. R. (2021). Artificial intelligence in surgery: Understanding the role of AI in surgical practice. McGraw-Hill Education / Medical.

Hayward, M. M. (2010). Lead-Seeking approaches. Springer Science & Business Media.

Higgs, J., Jones, M. A., Bds, S. L. P. M., & Christensen, N. (2008). Clinical reasoning in the health professions. Elsevier Health Sciences.

Holley, K., & Becker, S. (2021). AI-First Healthcare.

Honecker, F., & Dyshlovoy, S. A. (2018). Marine compounds and cancer. MDPI.

Ion Channel Factsbook: Extracellular Ligand-Gated Channels. (1995). Academic Press.

Jamshidi, M., Lalbakhsh, A., Talla, J., Peroutka, Z., Hadjilooei, F., Lalbakhsh, P., Jamshidi, M., La Spada, L., Mirmozafari, M., Dehghani, M., Sabet, A., Roshani, S., Roshani, S., Bayat-Makou, N., Mohamadzade, B., Malek, Z., Jamshidi, A., Kiani, S., Hashemi-Dezaki, H., & Mohyuddin, W. (2020). Artificial Intelligence and COVID-19: Deep learning approaches for diagnosis and treatment. IEEE Access, 8, 109581–109595. https://doi.org/10.1109/access.2020.3001973

Katsaras, J., & Gutberlet, T. (2013). Lipid bilayers: Structure and Interactions. Springer Science & Business Media.

Kemmler, W., Fröhlich, M., & Kleinöder, H. (2020). Whole-body electromyostimulation: a training technology to improve health and performance in humans? Frontiers Media SA.

Khang, A. (2023). AI and IoT-Based Technologies for Precision Medicine. IGI Global.
Kotu, V., & Deshpande, B. (2014). Predictive analytics and data mining: Concepts and Practice with RapidMiner. Morgan Kaufmann.
Koulaouzidis, A., & Marlicz, W. (2021). Diagnosis and treatment of small bowel disorders. MDPI.
Kulski, J. (2016). Next generation sequencing: Advances, Applications and Challenges. BoD – Books on Demand.
Kumar, Y., Koul, A., Singla, R., & Ijaz, M. F. (2022). Artificial intelligence in disease diagnosis: a systematic literature review, synthesizing framework and future research agenda. Journal of Ambient Intelligence and Humanized Computing, 14(7), 8459–8486. https://doi.org/10.1007/s12652-021-03612-z
Lambert, P., & Mastrangeli, M. (2019). Microscale surface tension and its applications. MDPI.
Lexicon of psychiatric and mental health terms. (1994).
Machine learning: The Power and Promise of Computers That Learn by Example. (2017).
Mahmoudi, M., & Rezaei, N. (2019). Nutrition and immunity. Springer.
Marschner, H. (1995). Mineral nutrition of higher plants. Gulf Professional Publishing.
Medicine, I. O., Services, B. O. H. C., & Summit, C. O. T. H. P. E. (2003). Health professions education: A Bridge to Quality. National Academies Press.
Medicine, N. a. O. S. E. A., Division, H. a. M., Policy, B. O. H. S., & Abuse, C. O. P. M. a. R. S. T. a. P. O. (2017). Pain management and the opioid epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use. National Academies Press.
Medicine, N. a. O. S. E. A., Division, H. a. M., Policy, B. O. H. S., & Health, R. O. G. a. P. (2020). Exploring the current landscape of consumer genomics: Proceedings of a Workshop. National Academies Press.
Medicine, N. a. O. S. E. A., Division, H. a. M., Services, B. O. H. C., & Disabilities, C. O. H. C. U. a. a. W. (2018). Health-Care utilization as a proxy in disability determination. National Academies Press.
Medicine, N. a. O. S. E. A., Division, H. a. M., Services, B. O. H. C., & Forum, N. C. P. (2018). The drug development paradigm in oncology: Proceedings of a Workshop. National Academies Press.
Medicine, N. a. O. S. E. A., Education, D. O. B. a. S. S. A., Division, H. a. M., Sciences, B. O. B. C. a. S., Policy, B. O. H. S., & Adults, C. O. T. H. a. M. D. O. S. I. a. L. I. O. (2020). Social isolation and loneliness in older adults: Opportunities for the Health Care System. National Academies Press.
Medicine, N. a. O. S. E. A., Medicine, N. a. O., & Well-Being, C. O. S. a. T. I. P. C. B. S. C. (2020a). Taking action against clinician burnout: A Systems Approach to Professional Well-Being. National Academies Press.
Medicine, N. a. O. S. E. A., Medicine, N. a. O., & Well-Being, C. O. S. a. T. I. P. C. B. S. C. (2020b). Taking action against clinician burnout: A Systems Approach to Professional Well-Being. National Academies Press.
Mogk, A., Genevaux, P., & Turgay, K. (2022). Functions and mechanisms of bacterial protein homeostasis and stress responses. Frontiers Media SA.
Molecular biology of the cell. (2002a).
Molecular biology of the cell. (2002b).
Molecular biology of the cell. (2002c).
Nations, F. a. a. O. O. T. U. (2013). The State of Food and Agriculture 2013: Food Systems for Better Nutrition. Fao.
Nayak, J., Naik, B., Pelusi, D., & Das, A. K. (2021). Handbook of Computational Intelligence in Biomedical Engineering and Healthcare. Academic Press.
Oecd. (2017). Tackling wasteful spending on health. OECD Publishing.
Oecd. (2019a). Artificial intelligence in society. OECD Publishing.
Oecd. (2019b). Artificial intelligence in society. OECD Publishing.

Oecd. (2019c). Artificial intelligence in society. OECD Publishing.
Oecd. (2019d). Artificial intelligence in society. OECD Publishing.
Otvos, L. (2008a). Peptide-Based drug design. Humana Press.
Otvos, L. (2008b). Peptide-Based drug design. Humana Press.
Otvos, L. (2008c). Peptide-Based drug design. Humana Press.
Padmanabhan, R., Meskin, N., & Moustafa, A. A. (2020). Mathematical models of cancer and different therapies: Unified Framework. Springer Nature.
Patel, V., Chisholm, D., Dua, T., Laxminarayan, R., & Medina-Mora, M. E. (2016). Mental, neurological, and substance use disorders.
Perk, J., De Backer, G., Gohlke, H., Graham, I., Reiner, Z., Verschuren, M., Albus, C., Benlian, P., Boysen, G., Cifkova, R., Deaton, C., Ebrahim, S., Fisher, M., Germano, G., Hobbs, R., Hoes, A., Karadeniz, S., Mezzani, A., Prescott, E., . . . Wolpert, C. (2012). European Guidelines on cardiovascular disease prevention in clinical practice (version 2012): The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts) * Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). European Heart Journal, 33(13), 1635–1701. https://doi.org/10.1093/eurheartj/ehs092
Popular Mechanics. (2000a).
Popular Mechanics. (2000b).
Popular science. (2005).
Program. (2022). 2022 International Conference on Decision Aid Sciences and Applications (DASA), i–cxiv. https://doi.org/10.1109/dasa54658.2022.9765271
Radenković, M., Milićević, I., Ahmadi-Dastgerdi, M., Bavaghar, N., Bavaghar, A., Shafiek, H., El-Khooly, M., Stenberg, V., Baldwin, A., Alghamdi, D., Alghamdi, A., Salah, D., Boujelben, K., & Dhouha, B. (2023). Updates on corticosteroids. In IntechOpen eBooks. https://doi.org/10.5772/intechopen.105342
Rahman, A., Anjum, S., & El-Seedi, H. (2018). Natural products in clinical trials. Bentham Science Publishers.
Rana, N. P., Slade, E. L., Sahu, G. P., Kizgin, H., Singh, N., Dey, B., Gutierrez, A., & Dwivedi, Y. K. (2019). Digital and social media marketing: Emerging Applications and Theoretical Development. Springer Nature.
Ranschaert, E. R., Morozov, S., & Algra, P. R. (2019a). Artificial intelligence in medical imaging: Opportunities, Applications and Risks. Springer.
Ranschaert, E. R., Morozov, S., & Algra, P. R. (2019b). Artificial intelligence in medical imaging: Opportunities, Applications and Risks. Springer.
Ranschaert, E. R., Morozov, S., & Algra, P. R. (2019c). Artificial intelligence in medical imaging: Opportunities, Applications and Risks. Springer.
Reuben, S. H. (2010). Reducing environmental cancer risk: What We Can Do Now. DIANE Publishing.
Sai, S., Gaur, A., Sai, R., Chamola, V., Guizani, M., & Rodrigues, J. J. P. C. (2024). Generative AI for Transformative Healthcare: A Comprehensive study of emerging models, applications, case studies, and limitations. IEEE Access, 12, 31078–31106. https://doi.org/10.1109/access.2024.3367715
Sazonov, E. (2018). Wearable sensors: Fundamentals, Implementation and Applications. Academic Press.
Schulte, P. A., & Perera, F. P. (2012). Molecular Epidemiology: Principles and Practices. Academic Press.

Seyfried, T. (2012). Cancer as a metabolic disease: On the Origin, Management, and Prevention of Cancer. John Wiley & Sons.

Teicher, B. A. (2007). Cancer drug resistance. Springer Science & Business Media.

Tsai, C. S. (2007). Biomacromolecules: Introduction to Structure, Function and Informatics. John Wiley & Sons.

VanderWalde, A. (2022a). Personalized medicine in oncology. Mdpi AG.

VanderWalde, A. (2022b). Personalized medicine in oncology. Mdpi AG.

VanderWalde, A. (2022c). Personalized medicine in oncology. Mdpi AG.

VanderWalde, A. (2022d). Personalized medicine in oncology. Mdpi AG.

VanderWalde, A. (2022e). Personalized medicine in oncology. Mdpi AG.

VGeetha, C. E. B. a. E. D. S. D. a. T. D. S. D. D. (2024). Multidisciplinary Approach in Research Area (Volume-12). The Hill Publication.

VGeetha, C. E. B. a. E. D. T. P. D. B. K. D. N. P. D. M. D. D. a. K. (2024). Multidisciplinary Research in Arts, Science & Commerce (Volume-2). The Hill Publication.

Weller, S. K. (2011). Alphaherpesviruses: Molecular Virology. Caister Academic Press Limited. Working mother. (2000).