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Review Article

Obesity and the role of artificial intelligence as a prediction tool

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ABSTRACT

Obesity is one of the leading public health challenges worldwide, with a growing prevalence and a strong association with chronic noncommunicable diseases. Traditional methods for risk assessment and clinical management have shown limitations in addressing the multifactorial complexity of this condition. In this context, artificial intelligence (AI) emerges as an innovative tool capable of enhancing risk prediction and optimizing treatment strategies. This article reviews current AI approaches applied to obesity, ranging from predictive models based on clinical, genomic, and behavioural data to personalized digital interventions in nutrition, physical activity, and therapeutic adherence. Furthermore, the main advantages, limitations, and ethical challenges of clinical implementation are analyzed. Finally, recommendations are provided to guide the responsible integration of AI into medical practice, aiming to advance toward more predictive, preventive, and personalized medicine in obesity management.

Keywords: Artificial intelligence, Obesity, Risk prediction, Machine learning, Digital health, Personalized medicine

INTRODUCTION

Obesity has been classified by the World Health Organization (WHO) as a global epidemic and one of the leading modifiable risk factors for premature mortality. In 2022, it was estimated that more than 1 billion people worldwide were living with obesity, including approximately 879 million adults and 159 million children and adolescents, representing a substantial increase compared with previous decades; prevalence has doubled in adults and quadrupled in children.[1] This situation constitutes a major challenge for health systems and global economic sustainability.

From both an epidemiological and clinical perspective, obesity is strongly associated with an increased incidence of type 2 diabetes, cardiovascular diseases, several types of cancer, and musculoskeletal disorders, significantly raising morbidity and mortality burdens at the population level.[2] The etiology of obesity is complex and multifactorial, resulting from the dynamic interaction between genetic predisposition, eating behaviours, levels of physical activity, metabolic processes, social determinants of health, and obesogenic environments. These factors limit the ability of conventional methods to provide accurate risk prediction and individualized treatment strategies.

In this context, artificial intelligence (AI) and machine learning (ML) have emerged as disruptive tools in biomedical research and clinical practice. They enable the integration of large and heterogeneous data sources including electronic health records, genomic biomarkers, metabolomic data, and behavioural information derived from wearable devices and mobile health applications producing predictive models capable of identifying hidden patterns and non-linear interactions that surpass traditional statistical approaches.[3] The present narrative review aims to analyze the role of AI/ML in obesity risk prediction and management, with particular emphasis on childhood obesity, synthesizing methodological approaches, recent findings, and recommendations for ethical and effective integration into clinical practice.

METHODOLOGY

It was a descriptive-exploratory study type of bibliographic review. The literature search period is from 2015 to 2024 in electronic databases such as PUBMED, ELSEVIER, and Web of Science. The keywords used in the MesH search were: artificial intelligence; obesity; risk prediction; machine learning; digital health; personalized medicine. Inclusion criteria: search terms, level of evidence, summaries and keywords, exclusion criteria: not related to the topic, outside the year limit, not available; They will be classified by year, type of study and level of evidence. For eligibility, a critical reading is carried out, level of evidence, documents available for analysis and according to the topic. A total of 30 sources were obtained for analysis and synthesis.

RESULTS

Applications of AI and machine learning in clinical practice

Over the past two decades, artificial intelligence (AI) and machine learning (ML) have evolved from experimental tools to widely adopted resources across multiple medical specialties. Their ability to analyze large and complex datasets has enabled remarkable progress in fields such as dermatology, radiology, cardiology, neurology, and pharmacology. In dermatology, for example, computer vision algorithms support the early detection of malignant skin lesions from high-resolution dermoscopic images, thereby reducing the likelihood of delayed diagnoses.[4]

In radiology, ML has facilitated the integration of information from various sources including imaging, genomic data, and pathology reports to deliver faster and more accurate diagnoses, while also reducing the workload of specialists. In this field, deep neural networks have proven especially valuable in breast cancer screening, showing sensitivity and specificity levels comparable to those of expert radiologists when trained on large mammography datasets.[5]

Similarly, in cardiology, deep learning models not only interpret electrocardiograms and echocardiograms but also detect subtle patterns linked to high-risk cardiovascular phenotypes. Such analyses can anticipate hemodynamic alterations, optimize risk stratification, and contribute to more personalized clinical decision-making.[6] More broadly, the implementation of AI/ML in medicine is laying the foundation for a paradigm in which prediction and prevention are increasingly integrated into diagnostic and therapeutic approaches.[6]

AI/ML in obesity care

The use of AI and ML has expanded into many areas of healthcare and, in recent years, has shown significant potential in the study and treatment of obesity. By analyzing complex and multidimensional data, these tools allow for the identification of risk factors, more accurate predictions, and enhanced clinical decision-making. Their implementation benefits patients by providing personalized nutrition plans, more efficient follow-up, and continuous monitoring of health outcomes.[7]

Among the most relevant applications are predictive models, which integrate clinical variables, dietary habits, sociodemographic factors, and anthropometric measurements to estimate the probability of developing obesity.[8] Likewise, image analytics plays an important role in assessing dietary intake and estimating energy expenditure, enabling more objective evaluation while reducing reliance on self-reported data.[8] In addition, AI-driven chatbots and digital counselling platforms provide patients with real-time support, fostering treatment adherence and promoting sustainable behavioural change.[9]

Taken together, these applications highlight the value of AI/ML not only in improving diagnostic and therapeutic precision but also in transforming the way patients engage with their own care. Particularly in childhood obesity, where prevention and education are critical, these technologies may become essential tools for promoting healthy lifestyles and preventing long-term complications.

AI/ML in childhood obesity

Childhood obesity is one of the most concerning public health problems of recent decades, given its rapid growth and the severe physical, psychological, and social consequences it entails. Excess weight in childhood not only increases the likelihood of obesity persisting into adulthood but also predisposes children to early onset of type 2 diabetes, hypertension, dyslipidaemia, and cardiovascular diseases.[10]

In this context, artificial intelligence and machine learning provide new opportunities for early detection, risk prediction, and the design of preventive strategies. Predictive models built on clinical data, growth patterns, physical activity records, dietary habits, and family history enable more accurate identification of children at risk of developing obesity. The availability of these algorithms in early life stages facilitates the implementation of more effective and personalized preventive measures.[11]

Additionally, wearable devices and mobile applications enhanced by AI have made it possible to collect real-time data on calorie intake, physical activity levels, and sleep patterns, which serves as a valuable resource for tailoring prevention programs to individual needs.[12] Complementary digital interventions, such as virtual assistants and interactive training programs, have proven useful in promoting healthy habits and engaging families in the behaviour-change process.

Table 1: AI applications in childhood obesity management.

AI application	Description	Benefits	Examples
Risk prediction	Uses predictors (e.g., screen time, diet) to assess risk.	Enables early, targeted interventions. May improve resource allocation for at-risk populations in schools and communities.	Customized strategies reduce child obesity risk. Social determinant mapping. Genomic profiling
Gamification	Transforms healthy habits into engaging games.	Motivates behaviour change through fun methods. Builds a sense of achievement and self-efficacy among children.	"Exergames" improve fitness and weight.
Ai-powered tools	Includes virtual coaching and active video games.	Integrates health into daily routines, providing real-time monitoring of diet, physical activity, and sleep patterns.	Apps promote activity and healthy eating.
Family-centered approaches	We suggest the involvement of families to create supportive environments.	Encourage lasting behaviour changes by addressing family dynamics and preferences. Fosters collaborative goal-setting among children, parents, and caregivers.	Tailored strategies maximize impact, and family members provide consistent support. Personalized weekly messages from a clinical team to mothers resulted in higher adherence and better weight management outcomes than automated messaging.
Long-term outcomes	Focuses on quality of life and reduced healthcare costs.	Instills lifelong healthy habits, improving mental health outcomes and reducing the likelihood of chronic diseases.	AI-driven lifestyle changes reduce the risks of chronic diseases. Monitoring trends in AI-driven EMR analytics. Enhanced clinical decision-making and empowered patient life coaching from chatbots

Wade AT, Davis CR, Dyer K, Hodgson JM, Woodman RJ, Murphy KJ. A Mediterranean diet supplemented with dairy foods improves markers of cardiovascular risk: Results from the MedDairy randomized controlled trial. Am. J. Clin. Nutr. 2018;108:1166-82.

Table 2: Current limitations and opportunities of AI/ML in obesity management.

Limitations	Opportunities
Data quality and lack of representativeness in training sets	Development of larger and more diverse datasets including clinical, genetic, behavioural, and environmental factors
Limited interpretability of predictive models (black-box issue)	Implementation of explainable AI (XAI) to increase trust and clinical adoption
Ethical and legal issues regarding privacy and equity	Creation of robust regulatory frameworks that ensure transparency, data protection, and fair access
Low adoption in clinical practice due to lack of training and integration	Integration of AI/ML with wearables, mobile apps, and EHR for real-time monitoring and personalized care
High implementation and maintenance costs	Interdisciplinary collaboration and public policies to promote sustainable, accessible, and ethical AI solutions

Khalid N, Qayyum A, Bilal M, Al-Fuqaha A, Qadir J. Privacy-preserving artificial intelligence in healthcare: Techniques and applications. Comput Biol Med. 2023;158:106848

Moreover, the integration of deep learning techniques into pediatric imaging, such as magnetic resonance imaging and ultrasound, has opened new pathways for studying body composition, detecting visceral fat deposits, and evaluating early metabolic alterations These approaches expand the understanding of underlying pathophysiological mechanisms and enhance the capacity for intervention before clinical complications arise.[13]

Overall, the application of AI/ML in childhood obesity represents a key tool for advancing toward preventive, personalized, and family-centered medicine. Nevertheless, ensuring data quality, minimizing bias in predictive models, and promoting equitable access to these technologies are necessary steps to ensure that their benefits extend to all children.

Challenges and future perspectives

Although artificial intelligence and machine learning have shown great potential in the field of obesity, their clinical and community applications still face several challenges. One of the main issues is the need to validate models across diverse populations and settings, since many algorithms are trained with datasets that are geographically or demographically limited, which reduces their global applicability.[14]

Another significant challenge is the integration of these tools into routine clinical practice. For healthcare professionals to adopt AI/ML systems, there must not only be strong scientific evidence of their effectiveness, but also user-friendly interfaces, interoperability with electronic medical record systems, and adequate training for healthcare staff.[14]

From a technical standpoint, limitations remain regarding data quality, model interpretability, and the risk of overfitting, which could result in unreliable predictions in real-world settings.[15] Furthermore, ensuring the sustainability of these solutions requires consideration of implementation costs, maintenance, and regular updates to keep pace with technological advances.

Looking ahead, it is expected that the combination of AI with personalized medicine, systems biology, and digital health will drive innovative approaches to obesity prevention and treatment. Collaboration among researchers, clinicians, engineers, and policymakers will be crucial to move toward an ethical, equitable, and effective use of these technologies.

Interdisciplinary Integration in the Use of AI/ML for Obesity.

The application of artificial intelligence and machine learning to obesity management cannot be viewed solely as a technological endeavor but rather as an interdisciplinary process requiring collaboration among multiple stakeholders. Obesity is a multifactorial condition that encompasses medical, psychological, nutritional, social, and environmental dimensions; therefore, integrating expertise from different fields is essential to designing effective solutions.[16]

Healthcare professionals provide the clinical expertise needed to correctly interpret algorithm outputs and translate them into therapeutic decisions. Engineers and data scientists contribute by developing accurate, secure, and patient-centered models. Likewise, nutritionists, psychologists, and educators play a critical role in implementing programs that promote sustainable lifestyle changes.[17]

At the institutional level, integrating AI/ML into obesity care requires public health policies that facilitate access to these technologies and promote equitable use. Equally important is the involvement of patients and their families, who provide crucial insights into daily habits, motivations, and barriers that predictive models alone cannot capture.[18]

DISCUSSION

Current limitations in the application of AI/ML to obesity

Despite the growing interest and progress achieved, the implementation of artificial intelligence and machine learning in the study and treatment of obesity still faces significant limitations. One of the main challenges is the quality of available data, as many models are trained with small or unrepresentative samples, which restricts their generalizability to diverse populations.[18] Furthermore, electronic health records often contain incomplete or fragmented information, which negatively affects algorithmic accuracy.

Another important issue is the interpretability of models. While deep learning techniques have shown strong predictive power, their “black-box” nature makes it difficult to clearly explain outcomes, generating mistrust among healthcare professionals and patients.[19] This problem is closely related to the need for transparency and external validation before these tools can be safely applied in real clinical settings.

There are also ethical and legal limitations associated with the use of sensitive data, such as genetic information, lifestyle habits, or medical conditions. The lack of universal regulatory frameworks hinders the protection of privacy and equitable access to these technologies, particularly in countries with less developed healthcare systems.[20]

Finally, clinical adoption of these tools remains limited due to the lack of specific AI training among healthcare professionals and the insufficient integration of algorithms into current healthcare infrastructures .[21] Addressing these limitations requires not only technical advances but also coordinated efforts in education, regulation, and public policy to ensure the safe and effective implementation of AI/ML in obesity management.

Opportunities for improvement in the use of AI/ML for obesity

Despite the limitations described, the application of artificial intelligence and machine learning to obesity management offers multiple opportunities for improvement. One key area is the development of larger and more diverse databases that incorporate clinical, genetic, behavioural, and environmental information from different populations. This would allow the construction of more representative models and help reduce bias in results.[22]

Another opportunity lies in the design of more transparent and interpretable algorithms that enable healthcare professionals to understand how predictions are generated. The implementation of explainable artificial intelligence (XAI) techniques could increase both trust and clinical adoption of these tools.[23]

In addition, integrating AI/ML with wearable devices, mobile applications, and electronic health records provides the possibility of establishing continuous monitoring systems capable of adapting interventions in real time to patients' needs.[24] This dynamic feedback capacity would enhance the personalization of interventions and improve long-term success.

Potential impact on public health

The integration of artificial intelligence and machine learning into obesity management has implications not only at the individual clinical level but also at a broader public health scale. These technologies can facilitate the identification of population-level risk patterns, enabling healthcare systems to anticipate trends and design preventive interventions targeted to specific communities.[25]

Furthermore, the ability to process large volumes of data from medical records, mobile devices, and social determinants of health provides an opportunity to implement real-time evidence-based policies. This could optimize resource allocation, enhance the efficiency of prevention programs, and reduce the costs associated with treating chronic diseases linked to obesity.[26]

From an educational perspective, AI-enhanced digital platforms offer support tools to promote healthy habits in schools, families, and communities, reinforcing prevention from early life stages.[27] There are also potential benefits in reducing health inequities, provided that these solutions are equitably accessible and culturally adapted to different socioeconomic contexts.

Limitations

Although artificial intelligence and machine learning have shown promising results in the study and management of obesity, their practical application faces several limitations. First, many of the models developed rely on restricted datasets with small sample sizes or limited population diversity, which undermines their generalizability across different clinical and cultural contexts.[28]

Second, algorithm interpretability remains a challenge. Most deep learning techniques function as black-box systems, making it difficult to identify the specific factors driving predictions. This opacity reduces healthcare professionals' trust and delays clinical adoption.[29]

Finally, clinical adoption is hindered by the lack of AI/ML training among healthcare professionals, resistance to technological change, and the high costs associated with implementation, maintenance, and continuous updates. Overcoming these limitations requires coordinated efforts among researchers, clinicians, institutions, and policymakers to ensure the responsible and sustainable development of AI in obesity care.[30]

CONCLUSIONS

Artificial intelligence and machine learning represent emerging tools of great value for the prediction and management of obesity in both adults and children. Their ability to integrate clinical, behavioural, genomic, and social data has demonstrated significant potential in the early identification of risk factors, the personalization of interventions, and the improvement of clinical decision-making. However, the practical implementation of these technologies remains limited by issues related to data quality and representativeness, the limited interpretability of models, and ethical challenges concerning privacy, equity, and transparency.

The future of AI/ML in addressing obesity will depend on the ability to overcome these limitations through the development of more diverse and standardized databases, the design of explainable algorithms, and the establishment of strong regulatory frameworks that ensure ethical and equitable application. Furthermore, interdisciplinary integration and collaboration among researchers, clinicians, engineers, and policymakers will be essential to consolidate a preventive and personalized approach. In this way, AI/ML may become a key resource not only at the individual clinical level but also in the implementation of public health strategies aimed at reducing the global burden of obesity.

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