Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

A Comprehensive Review of Various Factors Impacting Human Health: Implications for Pharmaceutical Education

Kiran C. Mahajan, Aditya Suryawanshi, Sujata Shendage, Shrikant Agawane, Anushka Kurhade, Himanshu Bhor

Department of Pharmaceutics, SGMSPM's Sharadchandra Pawar College of Pharmacy, Dumbarwadi (Otur), India
Email: kirancmahajan@gmail.com

Aim: This review aims to explore the multifaceted factors influencing human healthspecifically lifestyle decisions, environmental effects, and genetic predispositions and their implications for pharmaceutical education. Purpose: The purpose is to equip aspiring pharmacists with a comprehensive understanding of how these factors interact to effectively address health issues in diverse populations. Discussion: The discussion highlights the critical role of pharmacogenomics in tailoring medications to individual genetic profiles, thereby enhancing treatment efficacy and minimizing adverse reactions. It also emphasizes the significant impact of environmental factors, such as living conditions, healthcare access, and socioeconomic status, on health outcomes, advocating for a focus on systemic health inequities to promote equitable healthcare access. Additionally, lifestyle choices, including nutrition and exercise, are discussed as key components that can be influenced through education, fostering a proactive approach to patient care. To prepare students for real-world challenges, the review underscores the necessity of an interdisciplinary educational approach that integrates knowledge from behavioral sciences, social work, and public health, thereby enhancing critical thinking and problem-solving skills. Conclusion: the paper emphasizes the need for an integrated educational framework that synthesizes recent research on health determinants, aiming to cultivate a new generation of pharmacists equipped to improve health outcomes for various groups by fostering a deeper understanding of these interconnected issues.

Keywords: Human health, pharmaceutical education, health determinants, environmental factors, lifestyle choices, genetic predisposition.

1. Introduction

A complex web of interrelated elements that go beyond biological considerations affects human health. Health, according to the World Health Organization (WHO), is a condition of whole physical, mental, and social well-being rather than just the absence of illness[1]. This definition emphasizes how health is complex and influenced by a variety of elements, such as

genetic, environmental, social, and behavioral aspects.

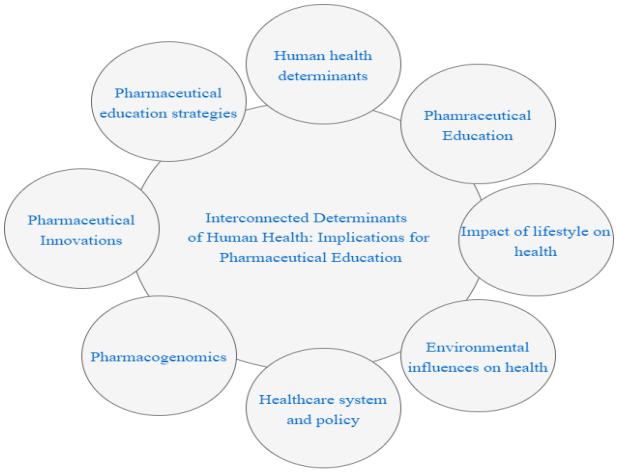

Figure. 1: Key Factors Influencing Human Health and Pharmaceutical Education

Genetic Determinants:

Individual health outcomes are greatly impacted by genetic predispositions. Pharmacogenomics, for example, shows that pharmacists must include genetic considerations into their practice since genetic variations impact medication metabolism. By customizing therapies according to genetic profiles, personalized medicine can increase therapeutic efficacy and reduce unfavorable drug effects[2]. Optimizing patient care and guaranteeing efficient drug management require an understanding of these genetic characteristics.

Environmental Influences:

Health disparities are significantly shaped by environmental factors, such as socioeconomic position and access to healthcare. According to the WHO, social determinants like poverty, education, and community resources have a big impact on health outcomes[3]. According to research, people from lower socioeconomic origins frequently encounter obstacles when trying to obtain high-quality healthcare, which results in a higher prevalence of chronic illnesses and worse general health[4]. For pharmacists, who may support community health programs and advocate for fair healthcare access, addressing these inequities is essential.

Lifestyle Choices:

Lifestyle decisions, including food, exercise, and drug usage, have a significant impact on health outcomes. Research indicates that healthy habits can either prevent or worsen diseases including diabetes, heart disease, and obesity[5].

DETERMINANTS OF HEALTH:

Genetic Factors:

Individual health outcomes are significantly influenced by genetic predisposition, which affects a person's response to treatment as well as their susceptibility to certain diseases. The risk of contracting diseases including diabetes, heart disease, and some types of cancer can be

influenced by specific genetic characteristics. Pharmacological reactions can be greatly impacted by this genetic variability, resulting in variations in patient safety and therapeutic efficacy. A crucial field of study with significant ramifications for personalized medicine is pharmacogenomics, which examines how a person's genes impact how they react to medications[6]. In contrast to the conventional "one-size-fits-all" approach, this discipline seeks to customize medical care to each patient's unique traits. Healthcare professionals can anticipate which drugs will work best and which would have negative side effects by knowing a patient's genetic composition. For example, the way that medications are digested in the body can vary depending on the genes that are involved in drug metabolism, such as CYP450 enzymes. Some people with specific genetic variations may absorb a medicine too slowly, increasing the risk of toxicity, while others may metabolize it too quickly, making it useless[7]. These observations are especially crucial for drugs with limited therapeutic windows, where it's difficult to strike a balance between safety and efficacy. Furthermore, pharmacogenomic testing can help choose the best drug for patients according to their genetic profiles. For instance, some antidepressants may be more beneficial to patients with particular genetic markers for depression than to others, resulting in faster therapeutic responses and fewer adverse effects[8].

Environmental Factors:

Environmental variables are important determinants of health, including living conditions, exposure to chemicals, and the quality of the air and water. Both individual well-being and general public health can be significantly impacted by these factors. For example, poor air quality has been connected to cardiovascular disorders, respiratory illnesses, and shortened life expectancy[9]. Similar to this, drinking water that has been tainted can cause a variety of health concerns, from stomach ailments to long-term developmental disorders in kids[10]. Health outcomes are greatly impacted by the built environment, which includes housing, transportation, and urban planning. Sedentary lifestyles, obesity, and related chronic diseases can be exacerbated in urban settings with inadequate access to green spaces, secure recreational areas, and sufficient public transit[11]. Furthermore, social interactions which are essential for mental health and community cohesion can be facilitated or hindered by neighborhood design. While places dominated by roads and parking lots may isolate residents and discourage outdoor activity, walkable neighborhoods with mixed-use projects, for instance, promote physical activity and social relationships[12]. Health outcomes are also significantly influenced by transportation networks. Having access to effective public transportation can lessen dependency on personal automobiles, encouraging exercise and lowering air pollution. On the other hand, populations without dependable transportation could have trouble getting access to jobs, wholesome food, and medical treatment, which would exacerbate health inequities[13]. Another important environmental factor of health is housing quality. Poor living conditions can expose people to mold, lead, and other dangerous materials, which can aggravate respiratory conditions and developmental abnormalities[14].

Lifestyle Choices:

Lifestyle decisions including food, exercise, smoking, and alcohol use play a major role in determining one's health. These decisions have a big impact on the likelihood of getting a variety of illnesses, including non-communicable diseases (NCDs). Since bad lifestyle choices

are increasingly being blamed for the growth of NCDs such obesity, diabetes, and cardiovascular illnesses, it is imperative that public health campaigns address these causes[15].

Health is fundamentally influenced by diet. Numerous chronic diseases can be avoided with a well-balanced diet full of fruits, vegetables, healthy grains, and lean meats. On the other hand, obesity and metabolic diseases are associated with diets heavy in processed foods, sweets, and harmful fats[16]. The World Health Organization (WHO), for example, notes that unhealthy eating patterns greatly increase the burden of disease worldwide, highlighting the necessity of dietary changes to enhance health outcomes[15]. Engaging in physical activity is another essential component of health maintenance. Frequent exercise is linked to a host of health advantages, such as better mental health, weight control, and cardiovascular health. Sedentary habits, on the other hand, raise the risk of obesity and other long-term illnesses[17]. To lower these risks, the WHO suggests engaging in moderate-intensity aerobic exercise for at least 150 minutes every week[18]. Other lifestyle decisions that have a significant impact on health include drinking alcohol and smoking. In addition to contributing to a number of malignancies, respiratory disorders, and cardiovascular problems, tobacco smoking is a major preventable cause of mortality globally[19]. Likewise, heavy alcohol use is associated with mental health issues, liver illness, and some types of cancer. Public health initiatives that encourage moderate alcohol use and discourage smoking have proven successful in enhancing population health[20].

Socioeconomics Status:

Access to resources and general well-being are significantly impacted by socioeconomic status (SES), making it a potent factor of health. Better living conditions, healthier dietary alternatives, and easier access to healthcare services are all common among those with higher socioeconomic status (SES), and these factors all work together to improve health outcomes. On the other hand, those with lower SES frequently face a number of obstacles that worsen health disparities and result in worse health outcomes[21]. One of the biggest benefits of having a higher SES is having access to healthcare. Higher socioeconomic group members are more likely to have health insurance, which enables them to seek prompt medical attention and preventive care. Better management of chronic disorders and early disease identification are made possible by this access[22]. On the other hand, those with lower socioeconomic status frequently experience financial limitations that restrict their capacity to pay for healthcare, which leads to treatment delays and higher rates of morbidity[23]. Another important area where SES has an impact is nutrition. Better nutritional choices are frequently associated with higher SES since those in this category can purchase healthier foods including whole grains, fresh fruits, and vegetables. However, those with lower socioeconomic status could live in "food deserts," places where it's difficult to find reasonably priced, wholesome food, which makes them more likely to rely on processed and unhealthy foods. Lower SES people have greater incidences of obesity, diabetes, and other diet-related disorders as a result of this dietary inequality[24]. Another important factor influencing health outcomes is the living environment. Better housing conditions, safer communities, and access to recreational areas are all often linked to higher SES and all of these factors support mental and physical health. On the other hand, those from lower socioeconomic origins can reside in places with greater crime, hazardous environmental conditions, and poor infrastructure, all of which could have a detrimental effect on their physical and emotional well-being[25]. Additionally, SES is linked to other socioeconomic determinants of health, like work and education. Higher educated people

typically have access to better employment possibilities, which can improve their chances of improving their health. Poorer health literacy and an inability to successfully navigate the healthcare system are associated with lower educational attainment, which is frequently found in groups with lower socioeconomic status[26].

Access to Healthcare:

In order to preserve health and guarantee favorable health outcomes for all populations, access to healthcare services is essential. Significant differences in health outcomes can result from obstacles like cost, transportation, and service accessibility that make it difficult for people to get the care they need[27]. Healthcare workers, such as pharmacists, who are crucial to patient care and advocacy, must comprehend these obstacles. Cost is one of the main obstacles to receiving healthcare. Exorbitant out-of-pocket costs, such as copayments, deductibles, and insurance premiums, may discourage people from obtaining medical attention. This is especially true for people in lower socioeconomic groups, when lack of funds may compel them to forgo essential medical care or preventative measures[28]. According to studies, not having insurance is linked to worse health outcomes, such as higher death rates and less use of preventive services[29]. Therefore, reducing health inequities requires tackling cost-related barriers. Accessing healthcare services is also significantly hampered by transportation, especially in underserved urban and rural locations. It could be challenging for people without dependable transportation to get to doctor's appointments, get prescription drugs, or receive specialist care. Sometimes these difficulties are made worse by the distance to medical facilities, which results in treatment delays and worse health outcomes[30]. By offering telemedicine services or prescription delivery options, pharmacists can play a significant role in this situation and assist patients with transportation constraints. Another important issue affecting access is the availability of healthcare services. Lack of medical professionals can restrict people's options for care, especially in primary care and mental health services. Underserved groups frequently experience delays in accessing critical treatments due to geographic differences in healthcare provision, which over time may aggravate their health issues[31]. As easily available medical professionals, pharmacists can assist close some of these gaps by providing necessary services including prescription management, health screenings, and vaccinations. In light of these difficulties, it is essential that pharmaceutical education thoroughly address healthcare access concerns. In addition to clinical expertise, future pharmacists need to be able to advocate for fair access to healthcare. This entails being aware of the socioeconomic determinants of health and actively taking part in outreach programs that support health equity in the community[32].

INTERCONNECTIONS BETWEEN HEALTH DETERMINANTS:

Individual and societal health outcomes are greatly influenced by the intricate web of linked determinants of health. This interdependence demonstrates how various elements can work together to influence health-related behaviors and resource accessibility. For example, socioeconomic status (SES) has a significant impact on a person's ability to acquire nutritious food selections, which in turn influences lifestyle decisions and general health[33]. Because members of these categories are more likely to reside in areas with grocery shops that provide a range of fresh produce and whole meals, higher SES is often linked to greater access to nutrient-dense foods[34]. On the other hand, those with lower SES frequently live in "food

deserts," where it is difficult to find nutritious food, which forces them to rely more on less expensive, processed meals that are rich in calories but low in nutrients[35]. This dietary pattern emphasizes the crucial connection between SES, nutrition, and health outcomes by contributing to obesity, diabetes, and other diet-related chronic diseases.

Moreover, socioeconomic considerations also affect the accessibility of healthcare services. Higher SES individuals are more likely to have health insurance and regular access to healthcare, which enables early illness detection and treatment. Conversely, people from lower socioeconomic backgrounds could encounter obstacles while trying to get healthcare, which could cause treatment to be delayed and health outcomes to deteriorate[36]. This leads to a vicious cycle in which ill health further reduces economic prospects, hence sustaining health inequalities over generations. Creating successful public health initiatives requires an understanding of these relationships. Positive results are more likely to be obtained via comprehensive initiatives that target several determinants of health. For instance, programs that increase underprivileged communities' access to nutritious meals in conjunction with nutrition and lifestyle education can result in better health outcomes and behaviors[37]. A more comprehensive approach to health can be promoted by combining social services with healthcare delivery to meet both medical and socioeconomic requirements. These intricate relationships must be included in the curriculum for pharmacological education. The impact of environmental and socioeconomic factors on patient health should be taught to aspiring pharmacists. Pharmacists can more successfully advocate for their patients and take part in community health initiatives if they have a better awareness of the larger context in which patients live as well as the obstacles they encounter[38].

IMPLICATIONS FOR PHARMACEUTICAL EDUCATION:

Curriculum Development:

The pharmaceutical curriculum must include the socioeconomic determinants of health in order to adequately prepare students to handle the intricacies of patient care. Socioeconomic position, education, environment, and social support are examples of social determinants that have a big impact on how people manage their health conditions and how their health outcomes turn out. For pharmacists, who are frequently at the frontline of patient interaction and care coordination, a thorough awareness of these issues is essential[39]. Future pharmacists must take health equity courses in order to be prepared to identify and resolve inequities in healthcare outcomes and access. Students are encouraged to comprehend how different social and economic factors lead to care barriers and how these barriers can be reduced through health equity education. Pharmacists can promote and put into practice policies that improve underprivileged people' access to drugs and healthcare services by highlighting the significance of equitable healthcare practices[40]. Another crucial element that needs to be included in the pharmaceutical curriculum is cultural competency. Pharmacists need to be skilled at comprehending and honoring cultural variations that impact health beliefs, habits, and preferences because patient populations are becoming more and more diverse. Pharmacists who receive cultural competency training are better equipped to interact with patients from different backgrounds, building trust and enhancing medication adherence. Culturally competent treatment has been linked to improved health outcomes and increased patient satisfaction, according to research[41]. Another crucial subject that needs to be covered in the

curriculum is how social variables affect drug adherence. The capacity of patients to follow their prescribed pharmaceutical regimens is greatly influenced by a number of factors, including their socioeconomic situation, literacy levels, and social support networks. Knowledgeable pharmacists are able to recognize possible obstacles to adherence and collaborate with patients to create customized solutions that improve health outcomes and compliance[42]. Additionally, students' learning experiences can be improved by include case studies and real-world examples that highlight the relationship between social factors and health outcomes. Students develop critical thinking skills and are more equipped to engage as proactive patient advocates when they are involved in conversations about how to handle these issues in practice[43].

Interdisciplinary Collabration:

In order to promote successful collaboration in patient care, it is crucial to teach aspiring pharmacists about the roles and contributions of other healthcare professionals. Pharmacists frequently play a crucial role in interdisciplinary healthcare teams. It has been demonstrated that collaborative care models, which place an emphasis on cooperation between different healthcare practitioners, improve patient outcomes, expedite treatment procedures, and increase overall healthcare efficiency[44]. Pharmacists can determine how they can best contribute to patient care by having a thorough awareness of the many responsibilities that are part of the healthcare team. For example, pharmacists can more effectively coordinate their efforts and guarantee that patients receive comprehensive and well-rounded care by understanding the distinct roles of doctors, nurses, social workers, and other allied health professionals. When handling complicated medical diseases that call for input from several specialties, this collaborative approach is very advantageous[45].

There are several ways to include multidisciplinary education in the pharmaceutical curriculum. Initiatives for interprofessional education (IPE), which unite students from various healthcare specialties, can offer a useful framework for comprehending communication techniques and team dynamics. These programs foster mutual respect, cooperative problem-solving skills, and an appreciation of the distinct knowledge that each profession offers to patient care[46]. IPE improves students' comprehension of team-based care and equips them for practical experience in collaborative settings, according to research[47]. Additionally, collaborative practice training aids in the development of critical abilities including shared decision-making, effective communication, and conflict resolution for aspiring pharmacists. These abilities are essential for managing the intricacies of healthcare delivery and creating a setting where each team member can help achieve the greatest results for patients[48]. Additionally, pharmacists can advocate for their own role within the team by being aware of the roles played by other healthcare providers. As specialists in pharmaceuticals, pharmacists are essential in managing medication-related problems, maximizing pharmacotherapy, and informing patients about their prescriptions. Pharmacists can increase prescription safety and adherence, which will ultimately benefit patients' health, by working with other medical experts and properly expressing their expertise[49].

Community Engagement:

Community involvement and service-learning opportunities should be highly valued in pharmaceutical education since they help students comprehend the health needs of various

groups and build the skills they need to effectively address those needs. Through the integration of academic study and community involvement, service-learning gives students real-world, hands-on experiences that improve their learning and serve the community[50].

Pharmacy students can learn more about the social determinants of health and the unique difficulties that various communities confront by becoming involved in the community. Students can get a personal look at the obstacles underprivileged groups face while trying to access healthcare services by taking part in community outreach initiatives, health fairs, and free clinics. In order for future pharmacists to provide more patient-centered treatment, this exposure is essential for developing empathy and cultural competency[51]. Additionally, students' clinical abilities can be improved through community engagement. Students can practice patient communication, medication counseling, and problem-solving in a variety of circumstances by applying their theoretical knowledge in real-world settings through service-learning. These kinds of experiences aid in the development of critical thinking and flexibility in students, two abilities necessary for efficient pharmacy practice[52]. According to research, students who take part in service-learning programs report feeling more confident in their clinical skills and having a better awareness of public health issues[53]. Additionally, these encounters can encourage pharmacy graduates to dedicate their lives to community service. Pharmacists are inspired to promote health equity and participate in public health efforts throughout their careers by interacting with diverse communities, which cultivates a feeling of social responsibility[54]. This is consistent with the changing role of pharmacists as medical professionals who actively support community health and wellbeing in addition to dispensing prescription drugs. The educational institution gains additional advantages from integrating community engagement within the pharmacy curriculum. It fortifies ties between educational institutions and neighborhood groups, enabling cooperative initiatives that can improve community healthcare delivery[55].

2. Case Studies:

Impact of Lifestyle Changes on Health Outcomes:

Changes in lifestyle have a significant effect on health outcomes, including the management and prevalence of chronic illnesses. Studies have consistently demonstrated that dietary, physical activity, alcohol, and smoking changes can result in notable benefits in health. A balanced diet high in fruits, vegetables, and whole grains, for example, has been linked to lower risks of diabetes, heart disease, and obesity[56]. In a similar vein, increased physical exercise can lower the risk of a number of chronic illnesses, improve mental health, and improve cardiovascular health[57]. One of the most significant lifestyle adjustments is giving up smoking; research shows that doing so significantly lowers the risk of heart disease, lung cancer, and respiratory conditions[58]. Limiting alcohol consumption is also essential because excessive use is associated with a number of health problems, including as liver disease, some types of cancer, and mental health difficulties[59]. Furthermore, these lifestyle modifications over time may enhance health outcomes for all populations, but especially for high-risk groups. It has been demonstrated that interventions that encourage lifestyle changes, like public awareness campaigns and community health initiatives, are successful in lowering the prevalence of chronic illnesses and improving people's quality of life in general[60].

Role of Pharmacist in Public Health:

As easily available medical practitioners who help to improve community health outcomes, pharmacists are essential to public health. They are in a position to offer essential services including medication management, health screenings, and immunization programs because of their in-depth understanding of drugs. Pharmacists assist in managing chronic conditions like diabetes and hypertension by performing health examinations and offering drug adherence counseling to patients, which eventually lowers hospital stays and medical expenses[61]. Additionally, pharmacists play a crucial role in immunization campaigns, especially in times of public health catastrophes like the COVID-19 pandemic. They have played a crucial role in delivering vaccinations, informing the public on the effectiveness and safety of vaccines, and clearing up false information[62]. In addition to raising immunization rates, this accessibility promotes public confidence in the healthcare system[63].

Pharmacists participate in community outreach activities that address health inequities and encourage preventative care in addition to providing direct patient care. Their participation in health education initiatives promotes healthier lives among populations by increasing awareness of important topics like substance misuse, obesity prevention, and smoking cessation[64]. To find and treat social determinants of health that affect patient outcomes, pharmacists can also work with interdisciplinary healthcare teams. Pharmacists strengthen their position as leaders in advancing public health objectives and health equity by supporting legislative reforms and doing public health research[65].

3. Future Directions in Pharmaceutical Education:

Adapting to the changing healthcare environment and the growing role of pharmacists is a growing emphasis of future directions in pharmaceutical education. Interprofessional education (IPE) must be prioritized since collaborative practice models are becoming crucial to provide all-encompassing patient care. Pharmacy schools may equip students to operate well in interdisciplinary teams by incorporating IPE into the curriculum. This will improve communication skills and promote respect between healthcare providers[66]. Furthermore, pharmaceutical education is changing as a result of the integration of digital health instruments and technology. Training programs that incorporate telepharmacy, electronic health records, and simulation-based learning can improve students' practical abilities and introduce them to the technology innovations that are changing patient care[67]. Additionally, in order to stay relevant in a variety of healthcare settings, pharmacists need to be prepared to offer virtual consultations and support as telehealth services become more and more popular[68]. The necessity of giving socioeconomic determinants of health and health equity more attention in the curriculum is another crucial area of concentration. It is essential to teach aspiring pharmacists about these elements so they can reduce inequalities in healthcare outcomes and access. This all-encompassing method equips pharmacists to carry out community-based treatments and speak up for marginalized groups[69]. Lastly, in a time where pharmaceutical sciences are developing at a rapid pace, cultivating a mindset of lifelong learning is crucial. Pharmacy school should incorporate ongoing education and continuous professional development to guarantee that graduates stay up to date on new treatments, changes in regulations, and changing patient demands[70].

4. Discussion:

A complex web of genetic, environmental, social, and behavioral factors all contribute to human health. Effectively addressing health disparities requires an understanding of how these variables interact, as each one is crucial in influencing both individual and community health outcomes.

The importance of genetic predispositions in health outcomes has been made clear by the development of pharmacogenomics. Understanding genetics can improve therapeutic efficacy and reduce side effects, as demonstrated by personalized medicine, which adjusts treatment to each patient's unique genetic profile. This method not only gives pharmacists and other healthcare professionals the ability to make well-informed judgments, but it also emphasizes how important it is to incorporate genetic literacy into pharmaceutical education. The capacity of pharmacists to understand genetic data will be essential for optimizing treatment strategies as they become more involved in patient-centered care. Environmental variables have a significant impact on health outcomes and access, particularly socioeconomic status and housing conditions. A cycle of health inequities results from the difficulties that people from lower socioeconomic backgrounds frequently encounter in obtaining wholesome food and high-quality medical care. In order to remove these obstacles, advocacy for fair access to healthcare is essential. Educational programs that increase knowledge of how the environment affects health can enable pharmacists to effectively advocate for their communities by promoting an awareness of the ways in which local resources and policies impact health. Lifestyle decisions, including food, exercise, and drug usage, are crucial in preventing long-term conditions like diabetes and obesity. Reducing the increasing incidence of these disorders requires public health campaigns that encourage healthier living. Being at the nexus of healthcare and community involvement, pharmacists can take the initiative in these projects. Pharmacists can make a substantial contribution to the prevention of chronic diseases by aiding community health initiatives and educating people about healthy lifestyle choices.

Access to healthcare resources and services is influenced by socioeconomic position, which is still a significant factor of health. Given the interconnectedness of socioeconomic issues, knowledge of social determinants of health must be incorporated into pharmacological education. We may promote a more comprehensive approach to patient care that takes into account not only medical demands but also the larger social context in which patients live by training aspiring pharmacists to identify and address these variables. Pharmaceutical education has to change to prepare pharmacists for the complexity of contemporary healthcare. A thorough grasp of patient care will be promoted by incorporating social determinants of health into the curriculum. Placing a strong emphasis on interdisciplinary collaboration equips pharmacists to function well in healthcare teams and improve patient outcomes by providing coordinated treatment. Future pharmacists will be better equipped to handle the various health requirements of communities thanks to chances for service-learning and community involvement, which will also foster empathy and cultural competency. Future directions in pharmaceutical education should include technology, interprofessional education, and lifelong learning as the role of pharmacists grows. In order to improve patient involvement and health outcomes, pharmacists need to be skilled in using the digital health tools and telepharmacy that are revolutionizing patient care. In order to ensure pharmacists' continuous efficacy as healthcare professionals, lifelong learning will be crucial to keeping them up to date on new

developments and trends in health.

5. Conclusion:

Genetic, environmental, social, and behavioral factors all interact intricately to shape human health, which is a complex concept. Addressing health inequities and enhancing both individual and community health outcomes require an understanding of these interrelated issues. Pharmacogenomics' emphasis on genetic predispositions emphasizes the value of personalized medicine by allowing medical professionals, including pharmacists, to customize therapies according to each patient's unique genetic profile. Advocacy for equitable healthcare access is necessary because environmental factors, such as living conditions and socioeconomic position, have a substantial impact on both overall well-being and access to healthcare. Lifestyle decisions also have a significant impact on health outcomes; the prevalence of chronic diseases is directly impacted by factors such as food, physical exercise, and substance use. Preventing diseases like obesity and diabetes requires public health campaigns that encourage healthy lifestyle choices. Moreover, socioeconomic status is a significant determinant that affects access to wholesome food and medical care, thereby sustaining health inequalities. To provide aspiring pharmacists with the information and abilities to handle these challenges, pharmaceutical education must change. A comprehensive understanding of patient care will be promoted by incorporating social determinants of health into the curriculum. Pharmacists will be better equipped to function in healthcare teams by prioritizing interdisciplinary collaboration, which will improve patient outcomes through coordinated treatment. Students will gain empathy and cultural competency by appreciating the various health needs of populations through community engagement and service-learning activities. Future paths in pharmaceutical education should include embracing technology, interprofessional education, and lifelong learning as the role of pharmacists continues to grow. We can increase pharmacists' contributions to public health and, eventually, improve everyone's health outcomes by educating them to address the complex nature of health and promote health equity. This all-encompassing strategy will guarantee that pharmacists are proactive champions for the health of the communities they serve in addition to being knowledgeable about medications.

CONFLICT OF INTEREST:

The authors declare that there is no conflict of interest.

ABBREVATIONS:

WHO: World Health Organization; SES: Socioeconomic Status; NCDs: Non-Communicable Diseases; IPE: Interprofessional Education

References

1. World Health Organization. Preamble to the Constitution of the World Health Organization. 1946.
2. Roden DM, Wilke RA, Kroemer HK, Stein CM. Pharmacogenomics: the genetics of variable

drug responses. Circulation. 2011 Apr 19;123(15):1661-70.
3. World Health Organization. Social determinants of health. 2021. Available from: WHO website.
4. Marmot MG, Smith GD, Stansfeld S, Patel C, North F, Head J, White I, Brunner E, Feeney A. Health inequalities among British civil servants: the Whitehall II study. InStress and the Brain 2013 Oct 23 (pp. 61-67). Routledge.
5. Janssen JA. Hyperinsulinemia and its pivotal role in aging, obesity, type 2 diabetes, cardiovascular disease and cancer. International journal of molecular sciences. 2021 Jul 21;22(15):7797.
6. Anghel SA, Dinu-Pirvu CE, Costache MA, Voiculescu AM, Ghica MV, Anuța V, Popa L. Receptor Pharmacogenomics: Deciphering Genetic Influence on Drug Response. International Journal of Molecular Sciences. 2024 Aug 29;25(17):9371.
7. Zhao M, Ma J, Li M, Zhang Y, Jiang B, Zhao X, Huai C, Shen L, Zhang N, He L, Qin S. Cytochrome P450 enzymes and drug metabolism in humans. International journal of molecular sciences. 2021 Nov 26;22(23):12808.
8. Dorji PW, Wangchuk S, Boonprasert K, Tarasuk M, Na-Bangchang K. Pharmacogenetic relevant polymorphisms of CYP2C9, CYP2C19, CYP2D6, and CYP3A5 in Bhutanese population. Drug Metabolism and Personalized Therapy. 2019 Dec 18;34(4):20190020.
9. World Health Organization. Air quality and health. 2021. Available from: WHO website.
10. UNICEF. Water, sanitation and hygiene. 2020. Available from: UNICEF website.
11. Frank LD, Engelke PO. The built environment and human activity patterns: exploring the impacts of urban form on public health. Journal of planning literature. 2001 Nov;16(2):202-18.
12. Chen Y, Li N, Lourenço J, Wang L, Cazelles B, Dong L, Li B, Liu Y, Jit M, Bosse NI, Abbott S. Measuring the effects of COVID-19-related disruption on dengue transmission in southeast Asia and Latin America: a statistical modelling study. The Lancet infectious diseases. 2022 May 1;22(5):657-67.
13. Litman T. Evaluating public transportation health benefits. Victoria, BC, Canada: Victoria Transport Policy Institute; 2012 Feb 15.
14. Hurst JL, Widman L, Brasileiro J, Maheux AJ, Evans-Paulson R, Choukas-Bradley S. Parents' attitudes towards the content of sex education in the USA: Associations with religiosity and political orientation. Sex Education. 2024 Jan 2;24(1):108-24.
15. World Health Organization. Noncommunicable diseases. 2020. Available from: WHO website.
16. Mozaffarian D. Dietary and policy priorities for cardiovascular disease, diabetes, and obesity: a comprehensive review. Circulation. 2016 Jan 12;133(2):187-225.
17. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. Cmaj. 2006 Mar 14;174(6):801-9.
18. World Health Organization. Physical activity. 2020. Available from: WHO website.
19. U.S. Department of Health and Human Services. The health consequences of smoking 50 years of progress: A report of the Surgeon General. 2014.
20. Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y, Patra J. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. The lancet. 2009 Jun 27;373(9682):2223-33.
21. Marmot M. Social determinants of health inequalities. The lancet. 2005 Mar 19;365(9464):1099-104.
22. McGinnis JM, Williams-Russo P, Knickman JR. The case for more active policy attention to health promotion. Health affairs. 2002 Mar;21(2):78-93.
23. Hadley J. Insurance coverage, medical care use, and short-term health changes following an unintentional injury or the onset of a chronic condition. Jama. 2007 Mar 14;297(10):1073-84.

24. Walker RE, Keane CR, Burke JG. Disparities and access to healthy food in the United States: A review of food deserts literature. Health & place. 2010 Sep 1;16(5):876-84.
25. Diez Roux AV. Residential environments and cardiovascular risk. Journal of urban health. 2003 Dec;80:569-89.
26. de Gelder R, Koster EM, van Buren LP, van Ameijden EJ, Harrison A, Birt CA, Verma A. Differences in adults' health and health behaviour between 16 European urban areas and the associations with socio-economic status and physical and social environment. The European Journal of Public Health. 2017 May 1;27(suppl_2):93-9.
27. Bodenheimer TS, Grumbach K. Understanding health policy: A clinical approach 4 th edition. New York, NY: McGraw-Hill Companies, Inc; 2004.
28. Hadley J, Holahan J, Coughlin T, Miller D. Covering The Uninsured In 2008: Current Costs, Sources Of Payment, And Incremental Costs: The cost of expanding coverage to the 16 percent of Americans who are uninsured would add 5 percent to national health spending. Health Affairs. 2008;27(Suppl1):w399-415.
29. McGinnis JM, Williams-Russo P, Knickman JR. The case for more active policy attention to health promotion. Health affairs. 2002 Mar;21(2):78-93.
30. Elliott JO, Lu B, Shneker BF, Moore JL, McAuley JW. The impact of 'social determinants of health'on epilepsy prevalence and reported medication use. Epilepsy research. 2009 Apr 1;84(2-3):135-45.
31. Diez Roux AV. Residential environments and cardiovascular risk. Journal of urban health. 2003 Dec;80:569-89.
32. FIP. Global Competency Framework for the Pharmacy Workforce. 2016. Available from: FIP website.
33. Marmot M. Social determinants of health inequalities. The lancet. 2005 Mar 19;365(9464):1099-104.
34. Walker RE, Keane CR, Burke JG. Disparities and access to healthy food in the United States: A review of food deserts literature. Health & place. 2010 Sep 1;16(5):876-84.
35. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML. Neighborhood racial composition, neighborhood poverty, and the spatial accessibility of supermarkets in metropolitan Detroit. American journal of public health. 2005 Apr;95(4):660-7.
36. Hadley J, Holahan J. How Much Medical Care Do The Uninsured Use, And Who Pays For It? A large amount of money from existing government sources is potentially available to finance expanded insurance coverage. Health Affairs. 2003;22(Suppl1):W3-66.
37. Futrell Dunaway L, Carton T, Ma P, Mundorf AR, Keel K, Theall KP. Beyond food access: the impact of parent-, home-, and neighborhood-level factors on Children's diets. International Journal of Environmental Research and Public Health. 2017 Jun;14(6):662.
38. FIP. Global Competency Framework for the Pharmacy Workforce. 2016. Available from: FIP website.
39. Zambrana RE, Parra-Medina D, Butler C. Social determinants of health: Intersectional impacts of race, class, ethnicity and place. The SAGE handbook of social studies in health and medicine. 2022:38-59.
40. Braveman P. Health disparities and health equity: concepts and measurement. Annual review of public health. 2006 Apr 21;27(1):167-94.
41. Filmer T, Herbig B. Effectiveness of interventions teaching cross-cultural competencies to health-related professionals with work experience: a systematic review. Journal of Continuing Education in the Health Professions. 2018 Jul 1;38(3):213-21.
42. Bosworth HB, Blalock DV, Hoyle RH, Czajkowski SM, Voils CI. The role of psychological science in efforts to improve cardiovascular medication adherence. American Psychologist. 2018 Nov;73(8):968.
43. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, Zhang X, Gregg EW, Albright AL,

Zhang P. Cost-effectiveness of interventions to manage diabetes: has the evidence changed since 2008?. Diabetes care. 2020 Jul 1;43(7):1557-92.
44. Machado AC, Czock A, Boone J, Anderson C, Leite SN. How interprofessional education is offered to pharmacists and pharmacy students: a scoping review. Journal of Interprofessional Education & Practice. 2022 Dec 1;29:100563.
45. Cox M, Cuff P, Brandt B, Reeves S, Zierler B. Measuring the impact of interprofessional education on collaborative practice and patient outcomes. Journal of interprofessional Care. 2016 Jan 2;30(1):1-3.
46. Barton L, Lackie K, Miller SG. Scoping Review: Interprofessional Simulation as an Effective Modality to Teaching Interprofessional Collaborative Competencies in the Emergency Department. Journal of Research in Interprofessional Practice and Education. 2023;13(1):1-31.
47. McNaughton SM, Flood B, Morgan J. Enablers and barriers of first-year common semesters and semester-long courses aimed at interprofessional collaborative practice capability development: A scoping review. Journal of Interprofessional Care. 2023 Sep 3;37(5):818-31.
48. Meyer BA, Seefeldt TM, Ngorsuraches S, Hendrickx LD, Lubeck PM, Farver DK, Heins JR. Interprofessional education in pharmacology using high-fidelity simulation. Currents in Pharmacy Teaching and Learning. 2017 Nov 1;9(6):1055-62.
49. Bajis D, Al-Haqan A, Mhlaba S, Bruno A, Bader L, Bates I. An evidence-led review of the FIP global competency framework for early career pharmacists training and development. Research in Social and Administrative Pharmacy. 2023 Mar 1;19(3):445-56.
50. Sinclair S, Kondejewski J, Jaggi P, Dennett L, des Ordons AL, Hack TF. What is the state of compassion education? A systematic review of compassion training in health care. Academic Medicine. 2021 Jul 1;96(7):1057-70.
51. Melody R, Michele KF, Negar G, Beliard VR. A systematic review of global health assessment for education in healthcare professions. Annals of global health. 2022;88(1).
52. Fricke J, Siddique SM, MSHP JA, DTMH M, Cohen ME, Mull NK. Healthcare Worker Implicit Bias Training and Education Rapid Review. Making Healthcare Safer IV: A Continuous Updating of Patient Safety Harms and Practices [Internet]. 2023 Jul.
53. Harris N, Bacon CE. Developing cognitive skills through active learning: a systematic review of health care professions. Athletic Training Education Journal. 2019 Apr 1;14(2):135-48.
54. Gargin MA. Public Health Instructors' Attitudes Regarding Online Instructional Course Design: A Collective Case Study.
55. Bellottie GD, Kirwin J, Allen RA, Anksorus HN, Bartelme KM, Bottenberg MM, Dula CC, Kane TH, Lee PH, McMillan A, Riley BL. Suggested pharmacy practice laboratory activities to align with pre-APPE domains in the Doctor of Pharmacy curriculum. Currents in Pharmacy Teaching and Learning. 2018 Sep 1;10(9):1303-20.
56. Mahmoud AM. An overview of epigenetics in obesity: the role of lifestyle and therapeutic interventions. International journal of molecular sciences. 2022 Jan 25;23(3):1341.
57. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, Macera CA, Heath GW, Thompson PD, Bauman A. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. Circulation. 2007;116(9):1081.
58. Boer R, Moolgavkar SH, Levy DT. Chapter 15: Impact of tobacco control on lung cancer mortality in the United States over the period 1975–2000—Summary and limitations. Risk Analysis: An International Journal. 2012 Aug;32:S190-201.
59. Rehm J, Taylor B, Patra J. Volume of alcohol consumption, patterns of drinking and burden of disease in the European region 2002. Addiction. 2006 Aug;101(8):1086-95.
60. United States. Public Health Service. Office of the Surgeon General. The health consequences of involuntary exposure to tobacco smoke: a report of the Surgeon General. US Department of

Health and Human Services, Public Health Service, Office of the Surgeon General; 2006.
61. Costa S, Guerreiro J, Teixeira I, Helling DK, Pereira J, Mateus C. Cost-effectiveness and cost-utility of hypertension and hyperlipidemia collaborative management between pharmacies and primary care in portugal alongside a trial compared with usual care (USFarmácia®). Frontiers in Pharmacology. 2022 Sep 8;13:903270.
62. Klauser AS, Halpern EJ, Strobl S, Gruber J, Feuchtner G, Bellmann-Weiler R, Weiss G, Stofferin H, Jaschke W. Dual-energy computed tomography detection of cardiovascular monosodium urate deposits in patients with gout. JAMA cardiology. 2019 Oct 1;4(10):1019-28.
63. Lavenue A, Simoneau I, Mahajan N, Srirangan K. Development and Implementation of Workshops to Optimize the Delivery of Vaccination Services in Community Pharmacies: Thinking beyond COVID-19. Pharmacy. 2023 Aug 13;11(4):129.
64. Desselle SP, Moczygemba LR, Coe AB, Hess K, Zgarrick DP. Applying contemporary management principles to implementing and evaluating value-added pharmacist services. Pharmacy. 2019 Jul 20;7(3):99.
65. Pinto GS, Bader L, Billberg K, Criddle D, Duggan C, El Bizri L, Gharat M, Hogue MD, Jacinto I, Oyeneyin Y, Zhou Y. Beating non-communicable diseases in primary health care: the contribution of pharmacists and guidance from FIP to support WHO goals. Research in Social and Administrative Pharmacy. 2020 Jul 1;16(7):974-7.
66. Illingworth P, Chelvanayagam S. The benefits of interprofessional education 10 years on. British Journal of Nursing. 2017 Jul 27;26(14):813-8.
67. Dyer CE, et al. Technology in pharmacy education: A systematic review. Am J Pharm Educ. 2018;82(9):6595.
68. Darlow B, Coleman K, McKinlay E, Donovan S, Beckingsale L, Gray B, Neser H, Perry M, Stanley J, Pullon S. The positive impact of interprofessional education: a controlled trial to evaluate a programme for health professional students. BMC medical education. 2015 Dec;15:1-9.
69. Darlow B, Brown M, Gallagher P, Gray L, McKinlay E, Purdie G, Wilson C, Pullon S. Longitudinal impact of interprofessional education on attitudes, skills and career trajectories: a protocol for a quasiexperimental study in New Zealand. BMJ open. 2018 Jan 1;8(1):e018510.
70. Marjadi B, Alfian R, Susanto Y, Tjandra L, Pratama AN, Schneider C. Pharmacists' continuing professional development for non-communicable diseases management: a consensus study. Research in Social and Administrative Pharmacy. 2022 Nov 1;18(11):3964-73.