Role Of Nanomedicine In Wound Healing Among Diabetic And Non-Diabetic Patients In KSA: A KAP Study

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Abstract

Background: A skin wound is caused by the integrity of the epidermal layer breaking down. A wound is any tissue damage that results in a disturbance of anatomical integrity and functional loss. Skin healing is essentially what wound healing entails. After an epidermal layer damage, wound healing starts right away and may take years. The concept of nanomedicine has evolved beyond its previous definition as a medication delivery mechanism, since nanomaterials have the potential to function as active therapeutic ingredients. These days, radiotherapy's effectiveness is restricted by the amount of energy that may be safely given to the patient is decreased by the tolerance of normal tissues next to the tumor.

An entirely new profile of material-cell biology interactions has been produced by nanotechnologies. Methods: To gain insight into the KAP on nanomedicine in wound healing among Saudi Arabian population, the research study deployed a cross-sectional survey. The questionnaire was administered in English. General parameters like the region of residence, age, gender, and work status were gathered for the metrics. For the purpose of analysing the data, the imported questionnaires were loaded into SPSS, the statistical package for the social sciences. Results: No Significant correlation exist between Gender and KAP factor. Knowledge domain (Male: P= 0.138, x2 =1.888, Female: P= 0.534, x2 = 1.768). Mean score for responses were 48.2%. Score above 48.2% were considered to be good practice. Among non-diabetic population increased awareness on nanomedicines in wound healing was observed in the year 2022. Conclusion: To gather broad information about public health awareness on nanomedicines, the KAP survey is helpful. In light of the study's findings, we draw the conclusion that training health and human services personnel to implement gender-based initiatives centred on nanomedicines in wound healing is essential.

Keywords: Nanomedicines, Diabetes, Wound healing, Gender, Age Factor, Average Analysis

Introduction

A skin wound is caused by the integrity of the epidermal layer breaking down. A wound is any tissue damage that results in a disturbance of anatomical integrity and functional loss. Skin healing is essentially what wound healing entails. After an epidermal layer damage, wound healing starts right away and may take years [1-2]. The highly ordered cellular, humoral, and molecular systems are part of this dynamic process. Inflammation, proliferation, and remodelling are the three overlapping stages of wound healing [3-4]. Any interference results in unusual wound healing [5]. Sometimes, primary and secondary healing are used to categorize wound healing. Wound progression occurs within three distinct, yet overlapping stages throughout the wound healing process: inflammation, proliferation (neo-angiogenesis, granulation, re-epithelialization), and maturation (extracellular matrix modification). The materials employed in the wound dressing can have a significant impact on wound care and the

effectiveness of wound healing in occluding the wounded tissue [6-7].

Numerous researches have provided a wealth of information on the effectiveness of traditional therapies in addressing the underlying causes of nonhealing wounds [8]. Traditional wound healing therapies have been studied both experimentally and therapeutically [9]. Due to the wide range of active and useful components they contain, including phenolic compounds, terpenoids, flavonoids, essential oils, alkaloids, fatty acids, and so on, medicinal plants might be considered as potent and promising treatments for improving wound healing processes [10]. There are two types of diabetes mellitus: type I, which is caused by the autoimmune system destroying the pancreatic beta cells, and type II, which is associated with insulin resistance and consequent pancreatic beta cell failure [11]. Diabetes mellitus is a metabolic disorder characterized by abnormal glucose metabolism. Hyperglycaemia, which is defined by low insulin secretion or insulin resistance, can lead to a number of problems, such as skin ulcers, diabetic nephropathy, neuropathy, cardiomyopathy, and hearing loss [12]. Nowadays, hundreds of millions of people worldwide suffer from diabetes as a result of changes in living brought about by societal growth and changes in lifestyle [13].

According to a recent assessment by many authors, more than 50 nanomedicine formulations are already authorized for clinical use [14]. The commercialized forms of these nanomedicines are authorized for treatment for cancer, anaesthetics, fungal treatments, iron replacement therapy, macular degeneration, and hereditary uncommon illnesses. The data also contain imaging agents that are nano- or microparticle-sized. Liposomes, iron colloids, protein-based NP, nano-emulsions, nanocrystals, and metal oxide nanoparticles comprise the bulk of authorized NP types [15]. The three novel formulations discussed in the preceding section demonstrate that new generations of nanomedicine are now making their way onto the market in addition to demonstrating that the number of authorized formulations is continuously rising. 2017 saw the FDA approve Vyxeos for the treatment of acute myeloid leukemia [16]. Because cellular dysfunction, microcirculatory abnormalities, high levels of oxidative stress, and hypoxia are the primary causes of amputation and disability, diabetic wounds can progress into chronic, intractable ulcers [17]. The concept of nanomedicine

has evolved beyond its previous definition as a medication delivery mechanism, since nanomaterials have the potential to function as active therapeutic ingredients. These days, radiotherapy's effectiveness is restricted by the amount of energy that may be safely given to the patient is decreased by the tolerance of normal tissues next to the tumor.

An entirely new profile of material-cell biology interactions has been produced by nanotechnologies [18]. The application of a novel class of radiation-enhancing nanoparticles may represent a significant advancement in the local radiotherapy treatment of solid malignancies [19]. Blood glucose management, surgical debridement, skin transplantation, wound dressing, and hyperbaric oxygen therapy are among the conventional clinical therapies [20]. These clinical interventions have a limited therapeutic impact on diabetic wound healing, despite being able to better manage symptoms. Furthermore, secondary damage is a common occurrence with diabetes therapies because to their extended duration, which can have a significant psychological and physical impact on patients [21]. Therefore, there is a pressing need for cutting-edge therapies for diabetic wounds that have the potential to be painless, scar-free, and successful [22]. Nanoparticles (NPs) derived from nanotechnology have drawn interest due to their revolutionary potential in understanding the biological environment and offering customized treatment strategies for wound healing. In addition to being tiny, stable, and readily absorbed by cells, they also offer high targeting or biocompatibility qualities and efficiently regulate the release and distribution of drugs [23].

These characteristics of NPs serve as the primary impetus for the creation of innovative platforms based on nanotechnology, which have a significant influence on the synthesis of extracellular matrix (ECM), collagen, and angiogenesis all of which are critical elements to support wound healing [16]. Because of their inherent nanoscale properties, NPs and other NPs-based platforms can interact with the wound healing process, impacting several cellular and molecular processes and promoting the repair of diabetic wounds [24]. Because of their distinct benefits, nanoparticles have garnered a lot of attention in the last ten years for the treatment of diabetic wounds [18]. Organic nanoparticles exhibit significant potential in the treatment of diabetic wounds because they have rich functional group structures that allow them to attach to medicines and growth factors more effectively, whereas metal nanoparticles' ions have strong antibacterial capabilities.

In addition to acting as carriers to increase the growth factors' stability in the wound region and regulate their release, protein-loaded nanoparticles can release a variety of growth factors [25]. Diabetes-related wounds have reduced matrix deposition, inadequate tissue repair function, and challenging wound healing because they lack EGF and its receptor. Despite being frequently used to treat diabetic wounds, EGF has a brief half-life [26]. Using a composite emulsion and a polylactic acid/glycolic acid copolymer, Qi et al. effectively created a stable EGF nanoparticle that had no harmful effects on cells. To the best of our knowledge, none of them have, however, provided us with a thorough overview, potential uses of gene therapy and nanotechnology to increase the bioavailability of medications for diabetic wound healing have been investigated.

Methods for Study

Participant recruitment

To gain insight into the KAP on role of nanomedicines in wound healing among Saudi Arabian population, the research study deployed a cross-sectional survey. The individuals that took part were selected at random from distinct elements of the nation. Snowball sampling was used to choose a total of 25 respondents. The attendees in the research had to be at least eighteen years old and have lived in various regions of Saudi Arabia.

Questionnaire

Part 1: The questionnaire, which had four sections, was administered in English. General parameters like the region of residence, age, gender, and work status were gathered for the metrics.

Part 2: Participants inquired questions on role of nanomedicines in wound healing in the Knowledge section. A right response was worth one point, and a wrong response was worth zero. After that, these scores were divided into two groups: high and low knowledge levels.

Section 3: Attitude: Participants' attitudes on the pros and drawbacks of nanomedicines in wound healing as a therapeutic approach were looked at. A higher rating suggested a more upbeat perspective on these subjects.

Section 4: Execution of strategies that boost participants' understanding and conviction about Nanomedicines in wound healing. Better practice is apparent by a higher score.

Statistical Analysis: For the purpose of analysing the data, the imported questionnaires were loaded into SPSS, the Statistical Package for the Social Sciences. The social and demographic information and KAP of the participants on nanomedicines in wound healing in Saudi Arabia were reviewed using the frequency percentage. Chi-square analyses were used for exploring demographic variables, including educational attainment. The association between dependent (KAP) and independent variables (age, gender, etc.) has been illustrated using scatter plots and box plots.

Results of Study

Figure 1: Participants' place of residence throughout KSA are highlighted on a map plot. Among 25 participants, Majority of them are from Al Jubail (9, 36%), followed by Riyadh (5, 20 %) and tiniest contribution from participants of Jeddah (1, 4 %), Madinah (3,12%) and Yanbu (4, 20%) respectively.

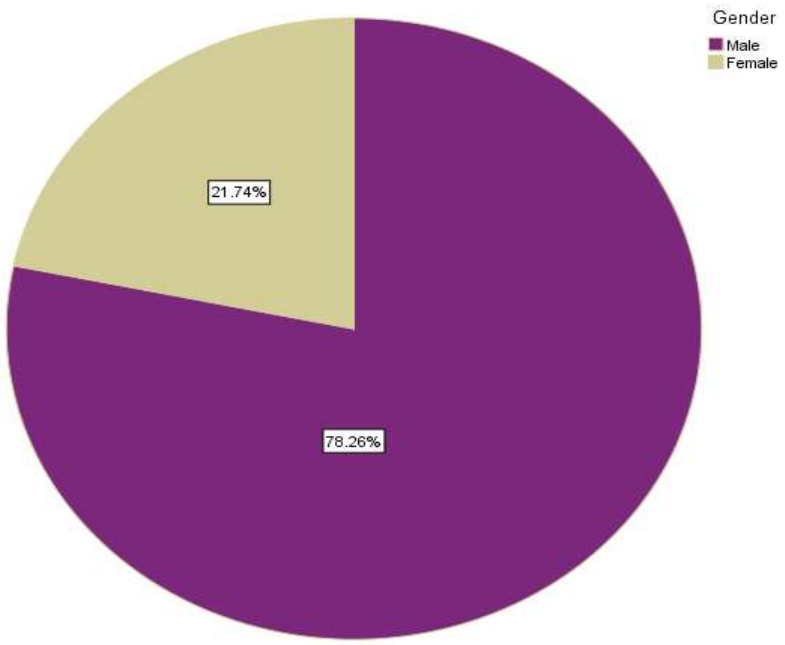

Figure 2: Illustrates the gender distribution of people participating in study. There were 21.74% of Female participants and 78.26% were Male participants.

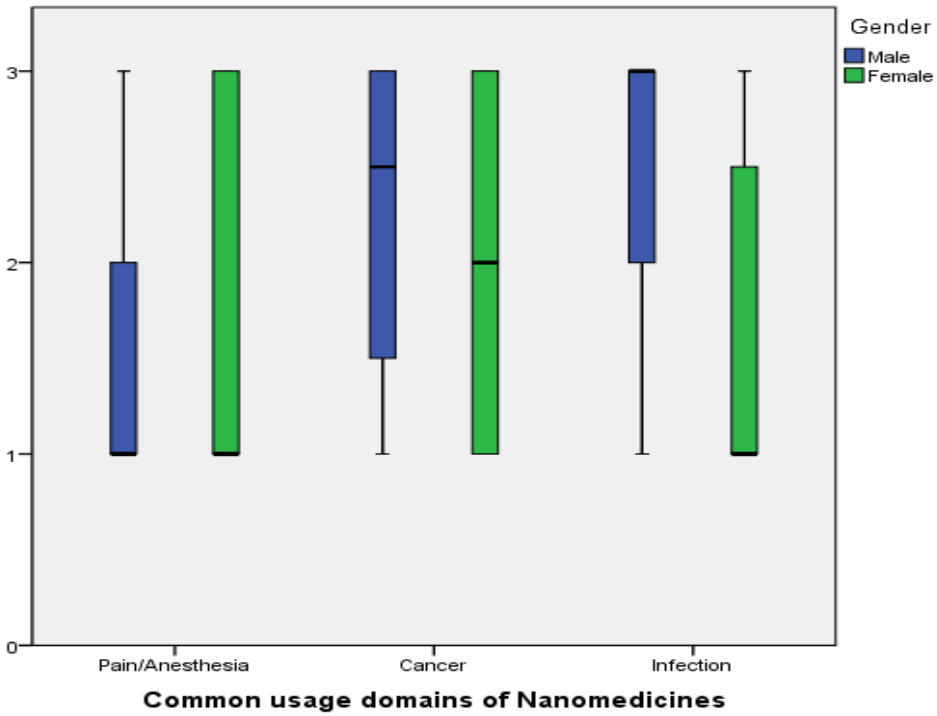

Figure 3: Box plot depicting common usage domain of nanoparticles among gender. Among Female gender there is positive skewed distribution with median = 2.

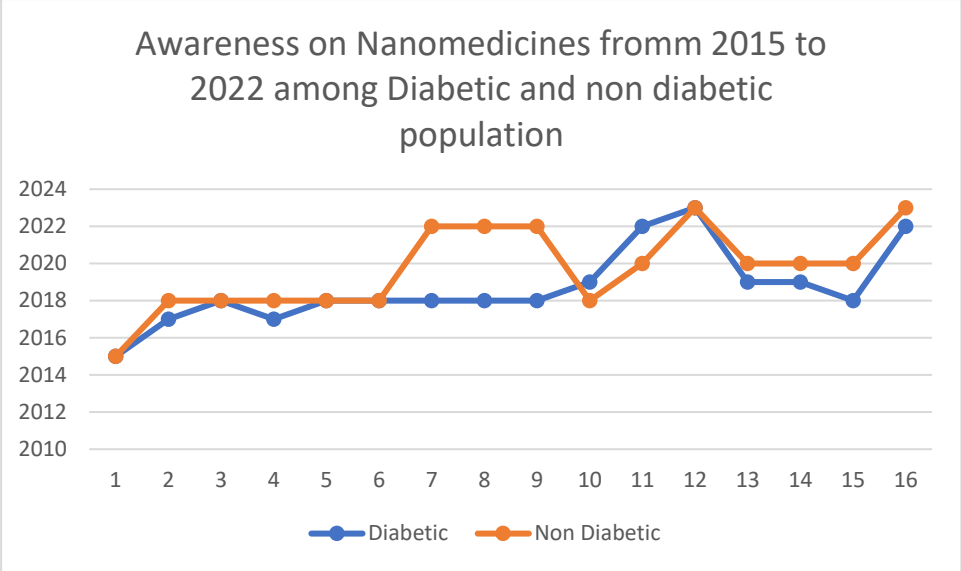

Figure 4: Exemplifies Awareness on Nanomedicines from 2015 to 2022 among Diabetic and non-diabetic population. Among non-diabetic population increased awareness on nanomedicines in wound healing was observed in the year 2022.

Table 1: Response of participants to knowledge-based questions. Correct response graded 1 and Incorrect response graded 0. Mean score of responses were 46 %. Score above 46 % were considered to be high knowledge level. Participants have fair knowledge on role of nanomedicines in wound healing (48 % and 44% respectively).

KQ	Frequency (%) correct response	Frequency (%) Incorrect response
K1	12(48%)	13 (52%)
K2	11 (44%)	14 (56%)

Table 2: Response of participants to Attitude based questions. Positive Attitude is graded 1 and Negative attitude is graded 0. Mean score of responses were 44%. Score above 44% were considered to Positive attitude towards cancer immunotherapy and Score below 44% were considered to be negative attitude. Participants have Positive attitude for Benefits of nanomedicines as a treatment modality in wound healing (64%).

AQ	Frequency (%) correct response	Frequency (%) Incorrect response
A1	16 (64%)	9 (36%)
A2	6 (24%)	19 (76%)

Table 3: Response of participants to practice based questions. A high score indicated improved practice. Mean score for responses were 48.2%. Score above 48.2% were considered to be good practice. Participants exhibited good practice towards believing Cancer Immunotherapy as a treatment modality in increasing survival rate of affected individuals.

PQ	Frequency (%) correct response	Frequency (%) Incorrect response
P1	8 (32%)	17 (68 %)
P2	15 (60 %)	10 (40 %)

Table 4: Depicts correlation between Gender and KAP factor. No Significant correlation exist between Gender and KAP factor. Knowledge Domain (Male: P= 0.138, x2 =1.888, Female: P= 0.534, x2 = 1.768).

Gender	**Knowledge**			**Attitude**			**Practice**		
	P value	X2	Likely hood ratio	P value	X2	Likely hood ratio	P value	X2	Likely hood ratio
Male	0.138	1.888	5.664	0.258	1.236	5.131	0.085	0.910	4.357
Female	0.534	1.768	5.304	0.809	0.140	4.959	0.367	2.348	4.610

Discussion

Serious illnesses known as wounds have a negative impact on people's quality of life everywhere. A quick and effective healing process may cut expenses and hospital stays, but because skin tissue structure is complicated, finding the right medication is still a challenge. Traditional methods based on

herbal and natural therapeutics are still recognized as promising alternative medications despite the latest advancements in wound management and the development of novel medications for wound healing and skin regeneration [27]. This is because these methods have a wide range of active ingredients, are easy to use, have few side effects, and are inexpensive. Among 25 participants, Majority of them are from Al Jubail (9, 36%), followed by Riyadh (5, 20 %) and tiniest contribution from participants of Jeddah (1, 4 %), Madinah (3,12%) and Riyadh (4, 20%) respectively.

There were 19.22% of Female participants and 80.78% were Male participants. In the current study most of the participants believe that nanomedicines are commonly used for pain and cancer. In This is in accordance with studies related to cancer are the subject of 65% of the active clinical studies. Nanomedicine has a lot to offer in the fight against cancer in terms of improved therapies and early detection [28]. It is crucial to emphasize that while reducing or eliminating cancer remains the primary objective, improving patients' quality of life throughout treatment also plays a crucial role in mitigating the frequently catastrophic side effects [29]. This is another area in which nanomedicine has a big role to play. In cancer applications, nanomaterials' ability to deliver medications locally while maintaining the therapeutic success and minimizing adverse effects is crucial [30-32]. From this angle, it is possible to build tailored immunotherapy and anti-cancer vaccines using nucleic acid-based technologies that are encapsulated in nanoparticle drug delivery systems.

However, many studies performed across the world reveals that entirely new profile of material-cell biology interactions has been produced by nanotechnologies [32-34]. The application of a novel class of radiation-enhancing nanoparticles may represent a significant advancement in the local radiotherapy treatment of solid malignancies. The features of nanomedicine also assist imaging [35]. For instance, the magnetic iron nanoparticle-based product called Magtrace makes it possible to track the sentinel node in breast cancer cases without the need for radio markers, which makes biopsy procedures more effective and allows for the identification of cancer cell movement [36]. Among non-diabetic population increased awareness on nanomedicines in wound healing was observed in the year 2022. Contradictorily, the first lipid-based nano formulation encasing siRNA, Onpattro, was licensed in 2018 to treat the uncommon illness transthyretin amyloidosis

[37]. The fact that nanomedicine was the first technological platform to address the requirement for nucleic acid delivery and make it accessible to patients makes this approval a significant accomplishment. Nucleotide-based medications do, in fact, present unique delivery issues despite having a huge therapeutic promise. In actuality, nucleotides have little to no chance of reaching the target site since they break down so quickly in vivo. Moreover, their entry into cells is electrostatically restricted since they possess a negative charge [38]. Therefore, in order to penetrate cells, nucleotide medications require both protection and a trojan horse. In addition to effectively encapsulating siRNA and preventing its breakdown in vivo, Onpattro's approach [39].

Advantages of the research

The poll was crafted pursuant to a preceding investigation and was first tested in an analogous setting. After that, the survey materials were written in English to help research participants understand them better and to lessen any difficulties that could have arisen while collecting data.

Study limitations

Analogous to all other cross-sectional research designs, this one displays the result and the exposure simultaneously. Therefore, using this study design alone to prove a cause-and-effect link is not practical.

Conclusion

The complex three-stage process of wound healing involves remodelling, proliferation, and inflammation. Furthermore, research has demonstrated that nanoparticulate systems possess active antibacterial properties against common drug-resistant microorganisms. When combined, nanoparticles and biopolymers form nanocomposites that are more effective in accelerating wound healing and tissue restoration. Many studies have been conducted on the application of nanomaterials for wound healing, however commercialization and standard clinical practice are still far off. No Significant correlation exist between Gender and KAP factor. Knowledge Domain (Male: P= 0.138, x2 =1.888, Female: P= 0.534, x2 = 1.768). To gather broad information about public health awareness on nanomedicines, the KAP survey is helpful. In light of the study's findings, we draw the conclusion that training health and human services personnel to implement gender-

based initiatives centred on nanomedicines in wound healing is essential.

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