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EFFECTIVENESS OF ONLINE EDUCATIONAL PROGRAMME ON LEVELS OF KNOWLEDGE, ATTITUDE AND PRACTICE AMONG NURSES TOWARD DIABETIC FOOT CARE IN JORDAN

Tesis Doctoral

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Appreciation

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List of Abbreviations

Abbreviation	Full Form
ABI	Ankle-brachial index
ADA	American Diabetes Association
CINAHL	Cumulative Index to Nursing and Allied Health Literature
DOS	Department of Statistics
DM	Diabetes mellitus
DF	Diabetic foot
DFSC	Diabetic Foot Screening Clinic
DFU	Diabetic foot ulcer
DMFS	diabetic mellitus foot syndrome
DPN	diabetic peripheral neuropathy
DALYs	disability-adjusted life years
ICU	Intensive Care Unit
IFD	International diabetes Federation
IWGDF	International Working Group on the Diabetic Foot
JNMC	Jordanian Nurse and Midwifery Council
JNC	Jordanian Nursing Council
KAP-DFUQ	Knowledge, Attitude, and Practice of Diabetic Foot Ulcer Questionnaire
KAP	knowledge, attitudes and practice
LPN	Licensed practical nurses
LFT	look, feel and test
M	Mean
MNSI	Michigan Neuropathy Screening Instrument
MOH	Ministry of Health
NCDEG	National Center for Diabetes, Endocrinology, and Genetics
NICE	National Institute for Health and Care Excellence
OPD	Outpatient department
OPDs	outpatient departments
PVD	peripheral vascular disease
RN	Registered nurses
P-value	Significant Value
SPSS	Statistical package for social sciences
(T2DM)	Type 2 Diabetes Mellitus

US	United State
WHO	World Health Organization

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Abstract

Background: Diabetic foot ulcer (DFU) conditions of the occurrence of infection, ulceration, or tissue damage in the foot of persons with a recent or previous diagnosis of diabetes mellitus (DM). This condition is often associated with peripheral neuropathy and/or peripheral arterial disease (PAD) in the lower limbs. It characterizes a significant global health challenge, both for affected individuals and healthcare systems. Diabetic foot complications are a main cause of recurrent admissions to the hospitals related to diabetes and are responsible for nearly half of all lower-limb amputation. As the incidence of diabetic foot ulcer increases globally, the need for professional nursing interventions has become more urgent than ever. Therefore, investing in the qualification and training of nursing personnel, and activating their role in educating and caring for diabetic foot, must be a health policy priority, because of its direct impact on reducing amputation and mortality rates, and enhancing the quality of health care in general.

Aim: This study aims to compare nurses' knowledge, attitudes, and practices regarding diabetic foot care before and after the online educational program. As a subsidiary objective, the intervention aims to evaluate the relationships between nurses' demographic characteristics and their knowledge, attitudes, and practices regarding diabetic foot care before and after the online educational programs. Finally, the relationship between Jordanian nurses' knowledge, attitudes, and practices regarding diabetic foot care and the relationship between the concepts of Amit Jain's "PENTAGON" Model of diabetic foot care among Jordanian nurses before and after the online educational programs is also evaluated.

Methods: A single-group quasi-experimental design was used, which involves administering the intervention to a single group and measuring outcomes before and after the design that guided the current study. Convenience sampling was used to calculate the sample size using G*Power 3.1 with a medium effect size (0.5), a significance level ($\alpha = 0.05$), and a power of 0.95. To address an attrition rate of 10–15%, 130 questionnaires were distributed. A total of 115 responses were received, ensuring a sufficient sample for analysis. Eleven governmental hospitals affiliated with the Ministry of Health (MOH) located in the southern, central, and northern regions of Jordan participated in the current study. The questionnaire, titled the "Knowledge, Attitude, and Practice Questionnaire for Diabetic Foot Ulcers (KAP-DFUQ)," contained 34 items. The study questionnaire was distributed to nurses in person prior to the in-hospital training program, and a Google Docs link containing the questionnaire was emailed following the training program. Through the online training program, six lectures on diabetic foot care were delivered to nurses based on the Amit Jain Pentagon Diabetic Foot Model. Descriptive statistics: The median test, paired-sample t-test, one-way ANOVA, and Pearson's correlation coefficient was used in the study.

Results: The educational program significantly enhanced nurses' knowledge, attitudes, and practice. Adequate knowledge improved from 46% to 63% (mean score: 5.17 to 10.83, $P < 0.001$), favorable attitudes from 52% to 61% (3.14 to 3.57, $P < 0.001$), and sufficient practice from 54% to 69% (3.86 to 4.34, $P < 0.001$). After the training program, developments in these parts

were strongly related with region, age, gender, qualification, work unit, and experience (all $P < 0.05$). Positive correlations were found between knowledge, attitudes, and practice ($r = 0.218–0.271$, $P < 0.05$). Significant increases were also detected in key PENTAGON concepts such as pathological lesions, education, new dressings, and amputation care (all $p < 0.001$), while no significant changes were observed in general condition ($p = 0.421$) or motivation ($p = 0.145$).

Conclusion: The e-learning program significantly improved nurses' knowledge, attitudes, and practices in diabetic foot ulcer care, with significant improvements in most concepts of the Amit-Jain Pentagon Model. The results support the Pentagon Model as an effective framework for nursing education and indicate its value in comprehensive, globally targeted professional development. It is recommended for use by academic institutions in educating nursing students about diabetic foot care, as well as by healthcare organizations and healthcare institutions providers for implementation during nurse training on diabetic foot care.

Keywords: diabetic foot ulcer, diabetes mellites, nurses knowledge, nurses attitudes, nurses practice, educational programme, pentagon model.

Resumen

Antecedentes: La úlcera del pie diabético (UPD) es la aparición de infección, ulceración o daño tisular en el pie de personas con un diagnóstico reciente o previo de diabetes mellitus (DM). Esta afección suele asociarse a neuropatía periférica y/o enfermedad arterial periférica (EAP) en las extremidades inferiors y supone un importante reto sanitario mundial, tanto para las personas afectadas como para los sistemas sanitarios, pues las complicaciones del pie diabético son una de las principales causas de ingresos recurrentes en los hospitales relacionados con la diabetes y son responsables de casi la mitad de todas las amputaciones de miembros inferiores. A medida que aumenta la incidencia de la úlcera del pie diabético en todo el mundo, la necesidad de intervenciones profesionales de enfermería se hace más urgente que nunca. Por lo tanto, invertir en la cualificación y formación del personal de enfermería y activar su papel en la educación y el cuidado del pie diabético, debe ser una prioridad de la política sanitaria, por su impacto directo en la reducción de las tasas de amputación y mortalidad y en la mejora de la calidad de la atención sanitaria en general.

Objetivo: Este estudio pretende comparar los niveles de conocimientos, actitudes y prácticas de las enfermeras en relación con el cuidado del pie diabético antes y después del programa educativo en línea. Subsidiariamente a este objetivo, la intervención pretende evaluar las relaciones entre las características demográficas de las enfermeras y sus conocimientos, actitudes y prácticas con respecto al cuidado del PD antes y después de los programas educativos en línea. Finalmente, también se evalúa la relación entre los niveles de conocimientos, actitudes y prácticas entre las enfermeras jordanas en relación con el cuidado del pie diabético y la relación entre los conceptos del Modelo «PENTAGON» de pie diabético de Amit Jain entre las enfermeras jordanas antes y después de los programas educativos en línea.

Métodos: Se utilizó un diseño cuasiexperimental de grupo único, que implica administrar la intervención a un único grupo y medir los resultados antes y después del diseño que guió el presente estudio. Se utilizó un muestreo de conveniencia para calcular el tamaño de la muestra mediante G*Power 3.1 con un tamaño del efecto medio (0,5), un nivel de significación ($\alpha = 0,05$) y una potencia de 0,95. Para hacer frente a una tasa de desgaste del 10-15%, se distribuyeron 130 cuestionarios. Se recibió un total de 115 respuestas, lo que garantizó una muestra suficiente para el análisis. Participaron en el presente estudio once hospitales públicos adscritos al Ministerio de Sanidad situados en las regiones meridional, central y septentrional de Jordania. El cuestionario, titulado «Cuestionario de conocimientos, actitudes y prácticas para las úlceras del pie diabético (KAP-DFUQ)», contenía 34 ítems. El cuestionario del estudio se distribuyó a las enfermeras en persona antes del programa de formación en el hospital y después del programa de formación se envió por correo electrónico un enlace de Google Docs que contenía el cuestionario. A través del programa de formación en línea, se impartieron a las enfermeras seis conferencias sobre el cuidado del pie diabético basadas en el modelo de pie diabético del Pentágono de Amit Jain. Estadística descriptiva: En el estudio se utilizaron la prueba de la mediana, la prueba t de muestras pareadas, el ANOVA unidireccional y el coeficiente de correlación de Pearson.

Resultados: El programa educativo mejoró significativamente los conocimientos, las actitudes y la práctica de las enfermeras. Los conocimientos adecuados mejoraron del 46% al 63% (puntuación media: 5,17 a 10,83; $p < 0,001$), las actitudes favorables del 52% al 61% (3,14 a 3,57; $p < 0,001$) y la práctica suficiente del 54% al 69% (3,86 a 4,34; $p < 0,001$). Tras el programa de formación, la evolución de estos aspectos estaba estrechamente relacionada con la región, la edad, el sexo, la cualificación, la unidad de trabajo y la experiencia (todos $P < 0,05$). Se encontraron correlaciones positivas entre conocimientos, actitudes y práctica ($r = 0,218$-$0,271$, $P < 0,05$). También se detectaron aumentos significativos en conceptos clave del PENTAGON como lesiones patológicas, educación, nuevos apósitos y cuidados de la amputación (todos $p < 0,001$), mientras que no se observaron cambios significativos en el estado general ($p = 0,421$) ni en la motivación ($p = 0,145$).

Conclusiones: El programa de aprendizaje electrónico mejoró significativamente los conocimientos, actitudes y prácticas de las enfermeras en el cuidado de las úlceras del pie diabético, con mejoras significativas en la mayoría de los conceptos del Modelo del Pentágono de Amit-Jain. Los resultados apoyan el Modelo del Pentágono como marco eficaz para la formación de enfermería e indican su valor en el desarrollo profesional integral y globalmente dirigido. Se recomienda su uso por parte de instituciones académicas en la educación de estudiantes de enfermería sobre el cuidado del pie diabético, así como por parte de organizaciones sanitarias y proveedores de instituciones sanitarias para su aplicación durante la formación de enfermería sobre el cuidado del pie diabético.

Palabras clave: úlcera del pie diabético, diabetes mellites, conocimientos de las enfermeras, actitudes de las enfermeras, práctica de las enfermeras, programa educativo, modelo del pentágono.

Resum

Antecedents: l'úlcera del peu diabètic (DFU) és l'aparició d'infecció, ulceració o dany tissular al peu de persones amb un diagnòstic recent o previ de diabetis mellitus (DM). Aquesta afecció sovint s'associa amb neuropatia perifèrica i/o malaltia arterial perifèrica (MAP) a les extremitats inferiors. Suposa un repte important de salut global, tant per a les persones afectades com també per als sistemes sanitaris. Les complicacions del peu diabètic són una de les principals causes d'ingressos recurrents als hospitals relacionats amb la diabetis i són responsables de gairebé la meitat de totes les amputacions d'extremitats inferiors. A mesura que augmenta la incidència de l'úlcera del peu diabètic a nivell mundial, la necessitat d'intervencions professionals d'infermeria s'ha tornat més urgent que mai. Per tant, invertir en la qualificació i formació del personal d'infermeria, i activar el seu paper en l'educació i cura del peu diabètic, ha de ser una prioritat de la política sanitària, pel seu impacte directe en la reducció de les taxes d'amputació i mortalitat, i en la millora de la qualitat de l'atenció sanitària en general.

Objectiu: Aquest estudi pretén comparar els nivells de coneixement, actituds i pràctiques de les infermeres respecte a la cura del peu diabètic abans i després d'un programa educatiu en línia. A més, busca avaluar les relacions entre les característiques demogràfiques de les infermeres i els seus coneixements, actituds i pràctiques pel que fa als programes educatius pre i post-online d'atenció DF. A més, té com a objectiu avaluar la relació entre els nivells de coneixement, actituds i pràctiques entre les infermeres jordanes pel que fa a la cura del peu diabètic i avaluar la relació entre els conceptes del model "PENTAGON" del peu diabètic d'Amit Jain entre les infermeres jordanes abans I després dels programes educatius en línia.

Mètodes: Es va utilitzar un disseny quasiexperimental d'un sol grup, que consisteix en administrar la intervenció a un sol grup i mesurar els resultats abans i després del disseny que va guiar l'estudi actual. Es va utilitzar el mostreig de conveniència per a calcular la mida de la mostra utilitzant G*Power 3.1 amb una mida d'efecte mitjà de 0.5, un nivell de significació d'$\alpha = 0.05$ i una potència de 0.95. Per abordar una taxa de desgast del 10-15%, es varen distribuir 130 qüestionaris. Es van rebre un total de 115 respostes, assegurant una mostra suficient per a l'anàlisi. Onze hospitals governamentals afiliats al Ministeri de Salut (MOH) situats a les regions sud, central i nord de Jordània van participar en l'estudi actual. El qüestionari, titulat "Qüestionari de coneixement, actitud i pràctica per a úlceres del peu diabètic (KAP-DFUQ, per les seues sigles en angles)", contenia 34 ítems. El qüestionari de l'estudi es va distribuir a les infermeres en persona abans del programa de formació a l'hospital i es va enviar per correu electrònic un enllaç de Google Docs que contenia el qüestionari després del programa de formació. A través del programa de formació en línia, es van impartir sis conferències sobre la cura del peu diabètic a infermeres basades en el model de peu diabètic del Pentàgon Amit Jain. Estadístiques descriptives: En l'estudi es van utilitzar la prova mitjana, la prova t de mostra aparellada, l'ANOVA unidireccional i el coeficient de correlació de Pearson.

Resultats: El programa educatiu va millorar significativament els coneixements, les actituds i la pràctica de les infermeres. El coneixement adequat va millorar del 46% al 63% (puntuació mitjana: 5,17 a 10,83, $P < 0,001$), les actituds favorables del 52% al 61% (3,14 a 3,57, $P < 0,001$) i la

pràctica suficient del 54% al 69% (3,86 a 4,34, P < 0,001). Després del programa de formació, els desenvolupaments en aquestes parts es van relacionar fortament amb la regió, l'edat, el gènere, la qualificació, la unitat de treball i l'experiència (tots P < 0,05). Es van trobar correlacions positives entre coneixement, actituds i pràctica (r = 0,218–0,271, P < 0,05). També es van detectar augments significatius en conceptes clau del Pentàgon com les lesions patològiques, l'educació, els nous apòsits i l'atenció a l'amputació (tots p < 0,001), mentre que no es van observar canvis significatius en l'estat general (p = 0,421) o la motivació (p = 0,145).

Conclusións: El programa d'aprenentatge electrònic va millorar significativament els coneixements, actituds i pràctiques de les infermeres en l'atenció de l'úlcera del peu diabètic, amb millores significatives en la majoria dels conceptes del model del Pentàgon Amit-Jain. Els resultats donen suport al model del Pentàgon com a marc eficaç per a l'educació d'infermeria i indiquen el seu valor en el desenvolupament professional integral i globalment dirigit. Es recomana que les institucions acadèmiques eduquen el seu alumnat d'infermeria sobre la cura del peu diabètic, així com les organitzacions sanitàries i els proveïdors d'institucions sanitàries per a la seva implementació durant la formació d'infermeres en la cura del peu diabètic.

Paraules clau: úlcera del peu diabètic, diabetis mellitus, coneixement de les infermeres, actituds de les infermeres, pràctica de les infermeres, programa educatiu, model de PENTAGON.

1. CHAPTER ONE: INTRODUCTION

1.1 Background

In 2022, diabetes was identified as the ninth leading cause of death according to the World Health Organization (WHO, 2022). Additionally, an estimated 1.5 million deaths were directly attributed to diabetes mellitus. The International Diabetes Federation (IDF,2022) reported that 537 million adults aged 20–79 years live with diabetes, which equates to 1 in every 10 adults. This number is projected to rise to 643 million by 2030 and 783 million by 2045.

Globally, 422 million individuals have diabetes, with a significant prevalence in low- and middle-income countries. The prevalence of diabetes has been progressively increasing over the past few years (WHO, 2022).

Diabetes is a chronic metabolic disease characterized by elevated blood glucose levels, which can lead to severe complications affecting the heart, blood vessels, eyes, kidneys, and nerves over time. The most common type of diabetes is type 2 diabetes, typically found in adults, which develops when the body becomes resistant to insulin or fails to produce enough insulin (WHO, 2022).

Diabetes accounted for 1.3 million deaths, representing 2.4% of all deaths. The prevalence of diabetes varies among countries in the Eastern Mediterranean Region. Among individuals with diabetes mellitus, 20% are at risk for foot ulceration due to neuropathy (Pourkazemi et al., 2020).

Jordan, a developing country, has experienced a noticeable rise in the prevalence of diabetes mellitus (DM) in recent decades. For instance, the prevalence of DM in men aged ≥25 years rose from 14.2% in 1994 to 18.3% in 2004; in 2009, it was 26.8%, and by 2017, it reached 32.4% (Ajlouni et al., 2019). The incidence of diabetic foot ulcers (DFUs) has been increasing over the past decade with an increasing prevalence of DM (Adem et al., 2020). For example, the prevalence of DFUs varies between 4% and 5.3% , with related amputations occurring at a rate of approximately 1.7% (Yousef AlAyed et al., 2017).

Conversely, the prevalence of various foot deformities in Jordan ranges from 1.7% to 17.4%. Sociodemographic factors such as age, gender, shoe choices, and diabetes-related microvascular complications (neuropathy and retinopathy) or hypertension were independently associated with foot deformities among the Jordanian diabetic population (Ababneh et al., 2020).

A descriptive cross-sectional study in Jordan examined the knowledge and practices of foot care among Jordanian patients with diabetes. The sample consisted of 1,085 participants. The summary of the findings is that more than half of the knowledge scores were written in the “good” range, in which the good practice scores were around 6%. Those classified as having poor knowledge accounted for 7.2%, while those with poor practice amounted to 42%. Statistically significant associations were found between the level of education and both knowledge and practice of foot self-care ($p = 0.006$). Additionally, a statistically significant relationship was identified between the level of knowledge and age group ($p = 0.002$)(Abu-Qamar, 2014).

DFUs affect approximately 15% of the total population with DM. In Saudi Arabia alone, there are 3.5 million diabetic patients (Abdullah et al., 2017). A DFU is a serious and disabling

complication of DM, characterized by lesions in deep tissues, which can lead to lower extremity amputations (Tuha et al., 2021).

Diabetic foot is defined as "infection, ulceration, or destruction of tissues of the foot of a person with currently or previously diagnosed DM, usually accompanied by neuropathy and/or peripheral artery disease in the lower extremity" (van Netten et al., 2020).

Diabetic foot disease poses a major international burden for patients and healthcare systems (Schaper et al., 2020). Diabetic foot problems are the leading cause of diabetes-related hospital admissions and account for nearly 50% of all lower-limb amputations (Waheida et al., 2015).

Good knowledge and practice are critical influences on the quality of diabetes care; they reduce the risk of diabetic foot complications and, ultimately, amputations (Pourkazemi et al., 2020). Nurses must be knowledgeable about this disorder to educate their patients effectively (Schaper et al., 2020)

Nurses play a vital role in the care and prevention of ulcers in patients with diabetic feet. They provide vital services such as patient education, ulcer prevention, and rehabilitation. Therefore, their knowledge, attitudes, and care toward patients with DFUs significantly contribute to improved patient care (Sukri et al., 2020; Yamas, 2020). Consequently, there is an increasing need for nursing interventions in diabetic care. Nurses are crucial in diabetic foot care, which includes health education, patient care, ulcer prevention, and rehabilitation.

However, DFU care is reported to be neglected in the nursing curriculum (Alotaibi et al., 2016; Kaya & Karaca, 2018). To date, no similar study has been conducted to assess the effectiveness of an educational program on the knowledge, attitudes, and practices of Jordanian nurses regarding DFU care.

1.2 Healthcare Delivery in Jordan

Jordan is a small lower-middle-income country in the Middle East, bordered by Syria to the north, Iraq and Saudi Arabia to the east, Saudi Arabia to the south, and Palestine to the west. The total population of Jordan is approximately 11.734.000, divided into three regions (central, north, and south), each consisting of four governorates. The central zone includes Amman, Balqa, Zarqa, Mafraq, and Madaba, comprising 69.1% of the total population. The northern zone includes Irbid, Jarash, Ajloun, and, representing 22.8% of the population, while the southern zone includes Karak, Tafila, Ma'an, and Aqaba, accounting for 8.1% (Department of Statistics, 2024).

In Jordan, the healthcare system is represented by the Ministry of Health (MOH), Royal Medical Services, universities and private hospitals. The Ministry of Health operates 92 Comprehensive healthcare centers and 30 hospitals, while the Royal Medical Services operates 10 hospitals that provide health services to about one-third of the population. Additionally, there are two universities hospitals: Jordan University Hospital and King Abdullah University Hospital, along with 60 private hospitals (MOH, 2024). The number of registered nurses, according to the Ministry of Health, is estimated at 7,540, with practical nurses numbering 2,228. Furthermore, the

number of registered nurses affiliated with the Jordan Nurses and Midwives Council (JNMC) is also documented (2022).

The majority of nurses in Jordan hold bachelor's degrees in nursing, while some have obtained diplomas in nursing. In 2022, the number of bachelor's degree nurses was 7,540, and diploma nurses numbered 2,228, according to the Ministry of Health. Both levels of nursing education provide limited knowledge, attitudes, and practices, particularly concerning diabetic foot care for patients (Al-me`ani & Al-Wahsh,2020). There is currently no documentation in Jordan to demonstrate differences between bachelor's and diploma nurses in terms of their preparation for diabetic foot care.

1.3 Problem Statement

Diabetic foot is a common reason for hospitalization among patients with DM, who are susceptible to frequent infections that may ultimately require lower extremity amputations (Bilal et al., 2018). The lifetime risk of developing an ulcer among patients with DM is 25%, and recurrent wounds are common after healing. Stigmatization, social isolation, unemployment, and depression are some of the negative effects that diabetic foot (DF) has on the quality of life for patients with DM (Buxadó et al., 2018). DF is one of the most prevalent complications of DM, increasing morbidity, mortality, and healthcare expenditures while reducing the quality of life of patients with DM (Everett & Mathioudakis, 2018; Sharmisthas et al., 2014). Therefore, gathering data related to nurses' knowledge, attitudes, and practices regarding DF care could provide a comprehensive understanding of this issue in Jordan. To the best of the researcher's knowledge, no studies have assessed the effectiveness of an educational program on the knowledge, attitude, and practices among nurses regarding diabetic foot care in Jordan. Consequently, this study aims to compare the levels of knowledge, attitudes, and practices of the nurses regarding diabetic foot care before and after the online educational program. Additionally, it seeks to assess the relationships between nurses' demographic characteristics and their knowledge, attitudes, and practices regarding DF care pre- and post-online educational programs.

1.4 Significance

Diabetic foot care is one of managing DM, essential for preventing DFUs. Studies have shown that people with diabetes who receive health education about foot care are at a lower risk of developing diabetic ulcers. Thus, health education is vital for helping people with diabetes prevent foot ulcers. Healthcare providers, including registered nurses (RNs) and practical nurses should regularly provide health education about diabetic foot care; however, their workload often prevents them from delivering this intervention, compounded by a lack of knowledge and practice regarding foot care. Based on initial interviews with diabetes program staff, the health education program is

not yet effectively implemented, and specific training on foot care for nurses is needed (Sjattar et al., 2019).

To prevent the onset and recurrence of diabetic foot disease, RNs and practical nurses, particularly those working with diabetic patients, should enhance their knowledge, attitudes, and practices regarding diabetic foot care. Additionally, education providers may wish to strengthen this subject area in diabetes foot care specialty education programs. Investigating the knowledge gap in diabetic foot care is recommended before developing future course content; the current study could serve as a useful tool for such an investigation due to its comprehensiveness and ease of administration.

This study emphasizes the importance of evaluating the effectiveness of the online educational program on the levels of knowledge, attitudes, and practice among nurses regarding diabetic foot care in Jordan. Identifying gaps and the outcomes of actions taken by nurses in primary healthcare will stimulate reflection within the scientific community and among professionals, ultimately improving preventive care for this pathology. This could contribute to the reformulation of strategies and actions that provide comprehensive care, minimizing complications such as amputations. Health service managers, particularly in primary care, are also alerted to need for the training professionals to achieve better care for people with diabetes and reduce the high healthcare costs arising from the exacerbation of cases (Arruda et al., 2019).

Therefore, information about standard nursing practice guidelines in diabetic foot care that can be utilized in nursing practice is lacking in Jordan. For this reason, the researcher is keen to emphasize the effectiveness of the educational program on the levels of knowledge, attitude, and practices of nurses regarding diabetic foot care in Jordan. The findings of this study would benefit policymakers at both institutional and national levels, such as the Ministry of Health, the Jordanian Nursing Council, and the JNMC, to adequately prepare nurses and plan for continuing education programs at post-basic levels in the future.

The findings of this study may contribute to nursing knowledge, nursing practice, and the development of further research in the nursing profession in the following ways: (1) the findings will help develop and organize training programs to enhance nursing knowledge and practice in providing care for patients, particularly those at risk for DFUs; (2) the findings will serve as a basis for guiding the development of nursing curricula and training courses related to the prevention and management of DFUs; and (3) the findings can be used as a baseline reference for future experimental research and mixed-methodology studies, such as evaluating the effectiveness of the educational programs in increasing nursing students' knowledge and practices regarding DFU.

No similar study has been conducted in Jordan, and no data estimates the effectiveness of the educational programs on nurses regarding diabetic foot care. Therefore, the present study aims to evaluate the effectiveness of an online educational program on the levels of knowledge, attitudes, and practice among nurses regarding diabetic foot care in Jordan.

1.5 General Aims

This study aims to compare the levels of knowledge, attitudes, and practices of nurses regarding diabetic foot care before and after the online educational program. Additionally, it seeks to assess the relationships between nurses demographic characteristics and their knowledge, attitudes, and practices regarding DF care pre and post-online educational programs. Furthermore, it aims to assess the relationship between the levels of knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care and to assess the relationship between the concepts of Amit Jain's Diabetic Foot "PENTAGON" Model among Jordanian nurses pre- and post-online educational programs.

1.6 Variables of the Study

Knowledge, attitudes, and practices of nurses are considered dependent variables (outcome variables) in the current study. The sociodemographic and work-related characteristics of nurses (gender, age, years of work experience, level of nursing qualification, graduate institution, current working hospital, current working unit, main source of knowledge, and last formal training on DFUs or diabetic foot care) are considered independent variables.

1.6.1 Theoretical and Operational Definitions of the Main Variables

Each variable in this study is theoretically defined according to the literature and operationally defined according to the instruments the researcher will use in this study.

Nurses' knowledge regarding diabetic foot care refers to their understanding and comprehension of the prevention and management of diabetic foot care across four components: (1) knowledge of predisposing factors and characteristics for DFUs; (2) knowledge of foot assessment; (3) knowledge of prevention and complications of foot ulcers; and (4) knowledge of DFU care) Table 1.1). Nurses' knowledge will be measured using a questionnaire designed to assess nurses' knowledge of diabetic foot care (Bilal et al., 2018a; Kumarasinghe et al., 2018; Sukri et al., 2020). A higher score indicates a higher level of knowledge

Nurses' attitudes regarding diabetic foot care refer to their perceptions and feelings about the prevention and management of DFUs(Table 1.1). These include three components: (1) attitudes regarding the clinical priority of caring for DFUs; (2) attitudes regarding nurses' interest in diabetic foot care; and (3) attitudes regarding the care of DFUs. Nurses' attitudes will be measured using a questionnaire designed to assess nurses' attitudes toward diabetic foot care (Bilal et al., 2018b; Kumarasinghe et al., 2018; Sukri et al., 2020). A higher score indicates a higher level of positive attitudes

Nurses' practices regarding diabetic foot care refer to nurses' perception of the frequency of their practices for the prevention and management of DFUs(Table 1-1). These include four

components: (1) Practice regarding foot assessment; (2) practices regarding patient education on diabetic foot care; (3) practices regarding appropriate footwear; and (4) practices regarding dressing and treatment of DFUs. Nurses' practices will be measured using the KAP-DFUQ developed by Al-me`ani & Al-Wahsh. A higher score indicates a higher level of practice

Table 1-1 Theoretical and Operational Definitions

Variable	Theoretical Definition	Operational Definition
Knowledge	Knowledge refers to the ability to acquire and utilize information, as well as understanding, learning experiences, and identifying relevant technologies (Abdullah et al., 2017).	Nurses' knowledge of diabetic foot care will be measured using a questionnaire designed for that purpose. The knowledge section contains 14 items. Levels of knowledge will be classified into two groups: a knowledge score ≥ median score will be considered "Adequate Knowledge." A knowledge score < median score will be considered "Inadequate Knowledge." See (Appendix B)
Attitude	Attitude reflects the result of reactions in specific situations, observed and explained based on the outcome of those reactions (Abdullah et al., 2017).	Nurses' attitudes toward diabetic foot care will be measured using a questionnaire designed to assess nurses' attitudes. The attitudes section contains eight items. Levels of attitudes will be classified into two groups. An attitude score ≤ median score will be considered a "non-favorable attitude." An attitude score > median score will be considered a "favorable attitude." See (Appendix B)
Practice	Practice indicates the integration of knowledge and habitual actions (Abdullah et al., 2017).	Nurses' practices will be measured using the KAP-DFUQ. The practices section comprises 12 questions. Levels of practice will be classified into two groups: a practice score ≥ median score will be considered "sufficient practice." A practice score < median score will be considered "insufficient practice." See (Appendix B)

1.7 Research Questions

1. Can the level of knowledge (i.e., adequate knowledge and inadequate knowledge) regarding diabetic foot care among Jordanian nurses be improved through an online educational intervention program?
2. Can the level of attitudes (i.e., favorable attitude & non-favorable attitude) regarding diabetic foot care among Jordanian nurses be improved through an online educational intervention program?
3. Can the level of practice (i.e., sufficient practice & insufficient practice) regarding diabetic foot care among Jordanian nurses be improved through an online educational intervention program?
4. What is the relationship between the knowledge levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses' pre- and post-online educational programs?
5. What is the relationship between the attitude levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses' pre and post-online educational programs?
6. What is the relationship between practice levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses' pre- and post-online educational programs?
7. Is there a relationship between the levels of knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre- and post-online educational programs?
8. Is there a relationship between the concepts of Amit Jain's Diabetic Foot "PENTAGON" Model among Jordanian nurses' pre and post-online educational programs?

1.8 Summary of Chapter One: Introduction

Diabetic foot ulcers continue to be a significant complication worldwide despite being a preventable complication; their prevalence varies by healthcare setting. However, nurses play a vital role in the care of diabetic patients; their knowledge and attitudes are essential to provide the best patient care. However, to the researcher's knowledge, there have been no studies to evaluate the effectiveness of a training program for nurses towards diabetic foot care based on Amit Jain's Pentagon diabetic foot model in Jordanian hospitals. Therefore, the overall purpose of this study is to compare the levels of knowledge, attitudes, and practices of nurses regarding diabetic foot care before and after the online educational program. In addition, this study seeks to assess the relationships between nurses' demographic characteristics and their knowledge, attitudes, and practices regarding diabetic foot care before and after the online educational programs. Furthermore, the research aims to assess the relationship between the levels of knowledge,

attitudes, and practices among Jordanian nurses regarding diabetic foot care, and assess the relationship between the concepts of Amit Jain's PENTAGON diabetic foot model among Jordanian nurses before and after the online educational programs.

1.9 Organization of the Thesis

The present dissertation has been accurately created to provide Effectiveness of online educational programme on levels of knowledge, attitude and practice among nurses toward diabetic foot care based on Amit Jain's Diabetic Foot Model as a conceptual framework. The Jordanian context is the study's primary focus. The study's objectives are dual: first, to integrate theoretical lookouts, empirical facts, and practical concerns; and second, to further professional practice and academic understanding in the area of diabetic foot care. The following section presents an outline of the thesis's organizational structure.

1.9.1 Chapter One: Introduction

The first chapter presents the background, the problem statement, the significance of the problem, the purpose of this study, the theoretical and operational definitions of the main variables, the scope of the study, the healthcare delivery in Jordan, the research questions, and the aspects of nursing management, education, and practice.

1.9.2 Chapter Two: Literature Review

The second chapter introduces the conceptual framework of diabetic foot ulcers (DFUs) and online educational programs to enhance nurses' knowledge, attitudes, and practice. It describes diabetes mellitus (DM), its pathophysiological characteristics, and its impact on foot health, with a focus on the alteration and development of diabetic foot ulcers. The conceptual framework in this chapter is according to Amit Jain's "PENTAGON" Diabetic Foot Model, a planned model for education about diabetic foot ulcers among health care professionals. eight Concepts of the model and their applications in practical nursing education are discussed in detail, demonstrating how strategic educational program can improve the prevention and management of diabetic foot ulcers.

1.9.3 Chapter Three: Methodology

The third chapter provides a discussion of the study design, study setting, sample size, participants based on the eligibility criteria mentioned in this chapter, sampling technique, content validity of the questionnaire, data collection methods, ethical considerations, pilot testing, intervention, how to integrate 8 concepts of Amit Jain pentagon model of diabetic foot into the training program, statistical analysis, and summary.

1.9.4 Chapter Four: The Results

The main purposes of fourth chapter are to describe the demographic characteristics of the participants who participated in the study and revealed the results of the analyses of the following: (a) the knowledge of DFU of nurses in Jordan pre and post online educational program, (b) the attitudes toward DFU of nurses in Jordan pre and post online educational program, (c) the practices of DFU of nurses in Jordan pre and post online educational programs , (d)Also, to further investigation the association between levels of knowledge, attitude, and practice of nurses and their demographic characteristics regarding diabetic foot care pre and post the online educational program.(E) a relationship between the knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre and post online educational programs, (F) a relationship between the concepts of Amit Jain`s Diabetic Foot " PENTAGON" Model among Jordanian nurses pre and post online educational program.

1.9.5 Chapter Five: Synthesis of Findings, Implications, and Conclusion

The fifth chapter discusses the main findings of this study and compares them with previous research. The purpose of this discussion is to explore the study's hypotheses and research questions, shedding light on the relationships observed between various factors. The results will be presented in seven sections, beginning with a focus on the demographic characteristics of the nurses in the study. It is important to provide both the percentage and actual number of participants in each category, as well as compare these findings to those from similar studies.

The second section will highlight the nurses' knowledge regarding diabetic foot care before and after the online educational program. This will be followed by an examination of their attitudes toward diabetic foot care, again comparing pre- and post-program data. In the fourth section, we will explore the nurses' practices in diabetic foot care, with a similar before-and-after analysis. The fifth section will investigate the relationships between the nurses' knowledge, attitudes, and practices, analyzing how these dimensions interact with each other, especially when influenced by demographic variables. The sixth section will focus on the interplay between the three domains of knowledge, attitude, and practice (KAP) within the framework of the online training program, showing how they collectively contribute to behavioral change. Finally, the seventh section will examine the relevance of Amit Jain's Diabetic Foot PENTAGON Model, assessing how its concepts are applied among Jordanian nurses before and after the educational program. Also, address the limitations of the study, their implications for management, training, research, and education, and provide conclusions and recommendations for future research.

2 CHAPTER TWO: LITERATURE REVIEW

2.1 Chapter Overview

This chapter discusses the conceptual model of diabetic foot ulcers (DFUs) and e-learning courses on improving knowledge, attitudes, and practices of nurses. The chapter is introduced with a description of diabetes mellitus (DM) with its pathophysiology and the effect on the feet with a focus on the transformation and evolution of DFUs.

One of the major highlights of the chapter is an assessment of the role of Jordanian nurses within DFU prevention and management. It measures their levels of knowledge, attitudes, and clinical performance to identify gaps that should be bridged based on structured learning interventions. The chapter reveals that online learning programs effectively bridge gaps, noting their contribution to enhancing clinical decision-making and patients' outcomes

The conceptual basis of the work is based on Amit Jain's Diabetic Foot "PENTAGON" Anew Model, a systematic protocol for the management of DFU. The elements of the model and their applications in practical areas of nursing education are discussed in detail, demonstrating how strategic educational interventions can optimize DFU prevention and management.

Through an in-depth literature review, the chapter collates primary scholarly sources of knowledge regarding DFU epidemiology, risk factors, management strategies, and digital learning solution effects. By providing a theory-based and evidence-informed platform, the chapter establishes a foundation for evaluating the effectiveness of online learning in enhancing competencies of nurses in managing DFU.

2.2 Introduction

Diabetes mellitus (DM) is a chronic, non-communicable disease that has become a major global health challenge due to its rapid increase in prevalence and severe complications. The condition significantly impacts public health due to its association with various complications, high mortality, and economic burden on healthcare systems worldwide (Wang et al., 2022). Consequently, Diabetic foot ulcers (DFU) are among the most critical and far-reaching complications of diabetes mellitus (DM) that are experienced by most of its population. Not only do diabetes ulcers compromise foot health but also pose tremendous infection, amputation, and loss of quality of life risks. The pathophysiology of diabetic foot ulcers (DFU) is characterized by multi-factorial complex processes that entail peripheral neuropathy, peripheral vascular disease, and abnormal wound healing processes (Armstrong et al., 2023).

The importance of nurses in managing individuals with DFUs is very vital. Their practice, attitudes, and knowledge have immediate care implications on patients. Deficiencies have, nonetheless, been reported concerning nurses' attitudes and perceptions of DFU, suggesting that there is need for targeted educational interventions (Mekonnen & Tadesse, 2023). For instance, evidence suggests that nurses have adequate levels of knowledge but that practice lags behind, stressing that evidence-based practice and ongoing continuing professional development is key (Homing & Taylor-Pearson, 2024).

Khan and Hussain (2023) indicated that online educational programs are capable of filling these gaps of knowledge. Online programs provide nurses convenient, affordable, and updated information that empowers nurses to improve skill levels of care of DFUs. By combining practice experience with theoretical expertise, eLearning has the potential to create improved attitudes and practice among health care practitioners. This research examines the theoretical definition for diabetic foot ulcers, and how nurses leverage online based-eLearning programs and centers to address diabetic foot ulcer issues.

2.3 Theoretical Framework

2.3.1 Search Strategy

2.3.1.1 Databases and Sources

In this study, the literature databases and sources comprised of:

2 Peer-reviewed journal articles extracted from the uploaded document.
3 Studies and reports discussing DFUs management, the epidemiology, and clinical significance.
4 Studies on how well online learning environments enhance nurses' expertise and methods.
5 Research on the Diabetic Foot "PENTAGON" Anew Model developed by Amit Jain and its use in nursing education

2.3.1.2 Search Terms and Keywords

The search terms and keywords in this study include:

1. "Diabetes Mellitus" AND "Diabetic Foot Ulcer" AND "Epidemiology"
2. "Nurses' Knowledge, Attitudes, and Practices" AND "Diabetic Foot Care"
3. "Diabetic Foot Prevention Strategies" AND "Amit Jain's PENTAGON Model"
4. "Online Educational Programs" AND "Nursing Training for Diabetic Foot Ulcers

2.3.2 Eligibility Criteria

2.3.2.1 Inclusion Criteria:

1 Peer-reviewed studies related to DFU epidemiology, risk factors, and management strategies.
2 Research on Amit Jain's PENTAGON Model and its integration into nursing education.
3 Studies which determine the effect of educational programs about foot care on nurses' knowledge, practice, and outcomes for patients with diabetes.

2.3.2.2 Exclusion Criteria:

1. Non-peer-reviewed sources or anecdotal reports.
2. Studies unrelated to DFU management or online educational programs.
3. Redundant or outdated research that does not contribute new insights.

2.3.3 Data Extraction and Analysis

All relevant studies from the document were carefully reviewed, categorized, and synthesized to ensure a streamlined and structured presentation of literature. Studies were assessed based on their relevance, objectives, and contributions to DFU management and nurse education. Where necessary, overlapping studies were merged to eliminate redundancy.

2.4 Overview of Diabetes Mellitus

Diabetes mellitus (DM) is a group of disorders characterized by raised blood levels of glucose. There are two main types of diabetes; Type 1 and Type 2 diabetes. However, the signs and symptoms of the two types are similar: 1) high blood glucose level; 2) glucose in urine; 3) ketones in urine; 4) frequency in passing urine; 5) thirst; 6) increase in appetite (usually type 1); 7) weight loss (usually type 1); 8) fatigue; 9) abdominal pain (Ramachandran, 2014; Sapra & Bhandari, 2023).

Type 2 diabetes can often be asymptomatic and only diagnosed on opportunistic screening or as a chance finding whilst the patient is being investigated or treated for other medical problems (Peer et al., 2020). The signs and symptoms of diabetes are related to the high levels of glucose in the blood and inability of the cells to utilize glucose due to a lack of insulin production or resistance to the effect of insulin in the body (Galaviz et al., 2015). Glucose is excreted by the renal tubules into the urine and this leads to increased urine production due to the osmotic effect of the glucose (water is drawn into and retained in the urine by the high levels of glucose) (Liman & Jialal, 2023). Thus, body levels of water are depleted and there is subsequent development of chronic thirst. The inability of the cells to use glucose as a primary fuel source leads to the metabolism of fats and amino acids and thus weight loss. Furthermore, the utilization of fats and amino acids as fuel in the cells leads to the production of ketones (which a strong acid) (Brutsaert, 2023). This acid is excreted in the urine and as they are negatively charged, they carry sodium and potassium ions with them, leading to electrolyte imbalance, assign of which is abdominal pain (Brutsaert, 2023).

2.5 Type 2 diabetes

This is the most common form of diabetes and is traditionally thought to be a disease of people over the age of 40 years, including in adolescents and young adults (Lascar et al., 2018; Larkin,

2023). The reasons for this increase are probably related to lifestyle factors, including the increase in the rates of obesity, overeating, and a lack of exercise (Xie et al., 2022). Type 2 diabetes is normally characterized by the development of resistance to the effects of insulin in the tissues, and a reduction in the ability of the beta cells to increase the production of insulin in response to this increased insulin resistance in the body (Cerf, 2013). The resulting high blood levels of glucose lead to damage of the beta cells, thus further reducing the production of insulin (Cui et al., 2024).

Inadequate diabetes management frequently results in hyperglycemia and is linked to a variety of long-term complications, such as vision loss or impairment, peripheral neuropathy, kidney failure, cardiovascular conditions, peripheral arterial disease, and the development of foot ulcers. In reality, people with diabetes are two to four times at risk of developing cardiovascular disease compared to those without it (American Diabetes Association [ADA], 2023) Rapid growth of Type 2 Diabetes Mellitus (T2DM) has resulted in major healthcare issues across the world. As of the year 2022, over 800 million people live with diabetes, which has doubled since 1990 (Hossain et al., 2024). In 2019, the overall prevalence of T2DM globally was estimated at around 437.9 cases, with an age-standardized rate of 5,282.9 per 100,000 population, which has increased by 49% from 1990 (Safiri et al., 2022).

Type 2 diabetes mellitus continues to be a prominent cause of death and disability globally. It caused an estimated 1.47 million deaths in 2019, with an age-standardized mortality of 18.5 per 100,000, a 10.8% increase compared to 1990 levels (Safiri et al., 2022). Also, the condition caused 66.3 million DALYs, a 27.6% rise compared to the past decades (Safiri et al., 2022).In geographic terms, the highest rates of 2019 were seen for Oceania (11,086.1 per 100,000), Central Latin America (8,505.6 per 100,000), and the Caribbean (7,479.2 per 100,000), and the lowest were seen for Eastern Europe and Sub-Saharan Africa (Safiri et al., 2022).T2DM confers a higher risk for complications that involve cardiovascular disease, kidney failure, blindness, and amputations of the lower limbs (Goyal et al., 2023). People with diabetes are twice to four times more likely to develop cardiovascular disease compared to those who are not diabetic (Goyal et al., 2023). The escalating cases and complications of T2DM underscore the pressing need for efficient prevention, early detection, and holistic management measures to avert its consequences (Goyal et al., 2023).

2.6 Overview of Diabetic Foot Ulcer

Studies have shown that patients with diabetes have approximately 19% to 34% lifetime risk of developing a foot ulcer, which makes diabetes the leading cause of lower limb amputations (McDermott et al., 2023). The causes of diabetic foot ulcers are neuropathic, ischemic or a mixture of both: 1) Neuropathic: The reduced sensation in the feet of patients with peripheral neuropathy means that they are often unaware of the mechanical stresses being placed on their feet due to poorly fitting foot ware or trauma, such as standing on a sharp object; 2) Ischemic: the reduced peripheral circulation in patients with long-term complications leads to easily damaged skin with a reduced ability to heal in response to damage (Sidawy, 2019; Packer et al., 2023).

Not all diabetic foot ulcers become infected, but when they do, the patient's limb, and sometimes life, can be in danger, as the wound does not heal rapidly and infection can spread easily owing to the reduction in the delivery of white blood cells to the peripheral tissues (Boulton et al., 2018). Diabetic foot ulcers are characterized by a classical triad of neuropathy, ischemia, and infection (Canca-Sanchez et al., 2024).

"Diabetic foot delay" and the "Diabetic foot push" are defined as follows: diabetic foot delay prolongs the time interval from the instance of being diagnosed with diabetes to the development of diabetic foot disease (high risk). A person is considered to have a high risk of diabetic foot once he or she develops neuropathy, peripheral arterial disease (ischemia), or both. Diabetic foot push prolongs the time interval from high-risk foot to the development of any complications, such as ulceration, gangrene, and Charcot foot (Jain, 2021a).

In Ecuador, a descriptive-retrospective study was conducted to determine the most common microorganisms involved in diabetic foot ulcer infection. The study population consisted of 70 clinical records depicting type 2 diabetes mellitus diagnosis, diabetic foot ulcers at any stage, culture application, and antibiogram theorization from private clinic staff, and the complete setup of the clinical records was analyzed. The following variables were studied: age (measured in years), sex, origin, lesion Wagner's classification, cultures, isolated microorganisms, and antibiogram reports. The hypothesis was as follows: there is a high incidence of diabetic foot disease in the presence of both the gram-positive bacteria Staphylococcus aureus and the gram-negative bacteria Escherichia coli. The findings revealed that the microorganisms with the greatest degree of incidence were the gram-negative bacteria Escherichia coli 27 (69.28%) and the gram-positive bacteria Staphylococcus aureus 25 (80%) (Vivanco et al., 2017).

Macdonald et al. (2020) conducted "a retrospective study in Scotland aimed at comparing the microbiological profile of DFIs treated at a Scottish tertiary hospital to that reported in the literature, gathering data regarding antimicrobial resistance, and investigating potential trends between the microbiological results and the nature or site of the clinical sample taken and the age or sex of the patients." "Seventy-three patients and 200 microbiological investigations were included. The findings revealed that of the 200 microbiological investigations, 62% were culture positive, of which 37.9% were polymicrobial and 62.1% were monomicrobial. Among the monomicrobial results (n = 77), most were gram-positive isolates (96.1%), and the most frequently isolated bacteria was S. aureus (84.4%). No methicillin-resistant S. aureus strains were reported. The prevalence of S. aureus in DFIs was associated with increasing age ($p = 0.021$), but no evidence of associations with sex, anatomical sample site or sample material was found. The study concluded that the microbiological profile of DFIs in Scotland resembles that reported elsewhere in the UK." (Macdonald et al., 2020)

In this context, gram-positive organisms, primarily S. aureus, are most frequently isolated from DFIs. The S. aureus isolates identified were largely susceptible to antibiotic therapy. An association between increasing patient age and the prevalence of S. aureus in DFIs was observed (Macdonald et al., 2020).

In Jordan, a study was conducted to further enhance the understanding of the source and management of diabetic foot ulcer infection in nongovernmental hospitals in Jordan. The total number of patients included in the study was 607; 331 patients were infected, which accounted for 54.4% of the total population. A total of 124 females (63%) were female, and 207 (37%) were male. There were 128 pus cultures, accounting for 21.1% of the total population. Forty female pus patients (31%) and 88 male pus patients (69%) were included. The results of the study revealed that out of 607 patients with diabetic foot ulceration (DFU), 130 out of 148 had diabetic mellitus foot syndrome (DMFS). Diabetic foot ulceration (DFU) therefore contributed to 20.3% of the DMFS among these subjects. The microbiological culture method involved a total of 17 different pathogenic microorganisms, one of which was yeast and 16 of which were bacteria, from diabetic foot swabs for ulcers. S. aureus was the most common pathogen, followed by E. coli, Acinetobacter spp. (MDR) and K. pneumoniae, Pseudomonas aeruginosa, Streptococcus mirabilis, Streptococcus agalactiae (group b), Acinetobacter spp. (MDR) and K. oxytoca ESBL), S. viridacea, and Enterobacter spp. ESBL and Staphylococcus coag. negative). Enterobacter spp. ESBL was the least common pathogen, and the study concluded that diabetic foot ulcer (DFU) accounts for approximately a quarter of diabetic patients' tissue infections and that the causative agents are bacteria and fungi (yeast). Most of the causative pathogens are Staphylococcus aureus and Acinetobacter spp. (MDR). The risk of developing multidrug-resistant drug isolates from diabetic foot ulcers was high (53% of the total isolated pathogens), especially K. pneumonia (K. pneumoniae), Escherichia coli (E. coli) and Proteus mirabilis bacteria (Abu-Harirah et al., 2021).

A cross-sectional study involving 87 adult diabetic foot patients (aged 18 and above) was carried out to identify clinically significant aerobic gram-positive and gram-negative pathogens associated with diabetic foot ulcers (DFUs) in Jordanian patients. The study specifically focused on staphylococcal species, aiming to determine the predominant molecular types of methicillin-resistant staphylococci (MRS) colonizing both DFUs and nasal cavities, as well as to assess their toxigenic potential and patterns of antimicrobial resistance. "The results of this study revealed that the DFU cultures were polymicrobial. Members of the genus Staphylococcus were the most common among the DFU-associated isolates found in 48.3% (n = 42) of all patients enrolled. Coagulase-negative staphylococci comprised 63.3% of the staphylococci isolated from DFUs, predominantly Staphylococcus epidermidis, in both DFU (7.6%) and nares (39.2%). Staphylococcus aureus was isolated from DFUs and nares in 14.2% and 9.8%, respectively, while 93% and 70% of these isolates were MRSA. Most MRSA strains carried type IV SCC (76.2%), whereas most methicillin-resistant coagulase-negative staphylococci (MR-CoNS) strains (61.9%) were no typeable in terms of SCC. The most common type of MRSA spa was t386 (23.8%). Most MRSA and MR-CoNS strains exhibited resistance to aminoglycosides, fluoroquinolones and macrolides and susceptibility to vancomycin, mupirocin and linezolid." (Al-bakri et al., 2021)

Aborajooh et al. (2022) conducted a cross-sectional prospective observational study in southern Jordan among patients with DFU, aimed at evaluating the clinical characteristics of DFU in southern Jordan and determine the microbiological aspects of DFU infection. "A total of 64 diabetic patients with DFU were included in this study. The findings revealed that most patients

included in the study were males, with a male-to-female ratio of 2.2:1. The mean age was 54 years (SD ± 10.7). The mean duration of DM was 16.4 years (SD ± 7.5), and the mean HbA1c was 9.9% (SD ± 2.1). Neuropathy and anemia were noted in 72% and 44% of patients, respectively. The most common bacterial isolates were gram-negative bacteria, accounting for 29 isolates (45.3%). Approximately 37.5% (24) of the bacterial isolates presented MDR patterns. Previous antibiotic use in the last 30 days was significantly associated with MDR bacteria (p value <0.05). A previous history of amputations, the presence of neuropathy, renal impairment, retinopathy, anemia, limited joint mobility and the presence of foot deformity were significantly associated with Wagner's grade ≥ three." (Aborajooh et al., 2022) .The study concluded that many factors affect and increase the risk of having high-grade diabetic foot ulcers. The most common bacterial isolate from diabetic foot ulcers was gram-negative bacteria. The high rates of MDR in this study reflect the loose implementation of regulations in Jordan regarding antibiotic dispensing (Aborajooh et al., 2022).

2.7 Assessment of Diabetic Foot Ulcer

This review highlights this new screening method from the Indian subcontinent. Amit Jain's triple assessment is a new, simple, fastest screening method that addresses the triad of diabetic foot effectively. The results revealed that Amit Jain's triple assessment has 3 components, namely, the look, feel and test (LFT) component, which effectively addresses all the triads of diabetic foot. In the look component, the parts of the foot that are observed are the dorsum of the foot, the plantar surface and the interdigital areas, which are used to identify infection or ulcers. In the Feel Component, the dorsalis pedis/anterior tibial artery and posterior tibial artery are palpated to assess blood flow to the foot. In the test component, the presence of neuropathy is detected by any of the following methods, which can be used either in isolation or in combination: the tuning fork test, monofilament test, pin prick test, Ipswich touch test, vibratip test, or biothesiometer test. The number of sites to be tested for sensation on the foot, ranging from 1 to 10 sites, has always been debated. Few recommend 10 sites, few recommend 5 sites, and few recommend 3 sites, with the commonly tested sites being pulp of the great toe, the 1st metatarsal head and the 5th metatarsal head region. Amit Jain's triple assessment for a foot would take just 10 to 20 seconds, wherein one with routine practice can look at the foot quickly, feel the pulse fast and test the sensation, especially at the pulp of the great toe, with either a vibratip, an Ipswich touch test or a monofilament. The review concluded that Amit Jain's triple assessment, an LFT screening tool, is a simple and fast screening method for diabetic foot disease that effectively addresses the triad of diabetic foot disease. This high-risk screening tool should be considered a minimum and mandatory evaluation tool by healthcare professionals treating diabetes-related problems, as it is a preventive care strategy. Studies through this basic screening tool have shown that the foot has still not been fully evaluated to address triopathy (Jain et al., 2019).

A descriptive retrospective study was performed in India to perform foot examinations via Amit Jain's Triple Assessment screening tool in patients in surgical wards. A total of 72 patients were included in this study as per the search of case records. The results revealed that the majority

of patients had diabetes for more than ten years, and males were more commonly affected. All patients were diagnosed with diabetic foot with a varied spectrum of associated lesions alone or in combination. Surgical debridement (66.66%) was the most common procedure performed in these patients. The affected foot of all patients was examined, with component assessment of feeling pedal pulses performed in 86.11% of the patients and testing for sensation performed in 25% of the patients. In the contralateral foot, 58% of the patients were examined; similarly, pedal pulses were examined, and foot sensations were not tested in any of them. The study concluded that despite foot examination being of paramount importance, it is often incomplete and inadequate in diabetic foot subjects, as is also evident from the observations of the present study. Amit Jain's Triple assessment of diabetic feet is a rapid, inexpensive screening tool for obtaining basic foot information to segregate at-risk feet and offer preventive care against amputation (Prajapati et al., 2018).

2.8 Epidemiological and Clinical Importance

The global burden of diabetes is increasing, with a projected rise to 700 million by 2045 (Saeedi et al., 2019). Jordan has experienced a significant increase in DM prevalence, with an estimated 23.7% of adults affected. There is a need for strong prevention and control measures since due to the financial and medical burden of DM and DFUs. Working on epidemiological evidence, there is the need for increased public health programs due to a large relationship that exists between people with diabetes and a bad lifestyle (Gregg et al., 2023).

Diabetes mellitus has a common aftermath that is diabetic foot ulcers (DFUs), which leads to a higher risk of amputation, massive morbidity, and enormous healthcare costs globally. This chapter examines recent scholarly research concerning the epidemiology, risk factors, clinical outcomes, and recent management methods associated with diabetic foot ulcers (Packer et al., 2023).

A higher proportion of diabetic patient is affected by DFUs. Armstrong et al (2017) approximated that 15% to 25% of diabetic patients develop an average of a DFU over their lifetime. Zhang et al. (2020) said that because of a lack of exposure to proper diabetes care, DFU is prevalent in low- and middle-income countries with a high prevalence among the elderly. Armstrong et al. (2017) posited that DFUs results to 85% of diabetes-related amputations being a primary cause of non-traumatic lower-extremity amputations. Catching and treating diabetic foot ulcers (DFUs) early is really important. If left unchecked, they can turn into something serious—but the good news is that many of these ulcers can actually be prevented with the right care. In their study, Apelqvist et al. (2017) stated that there are a few main reasons why they develop in the first place. Nerve damage (which is common in diabetes) can make it hard to feel injuries on the feet, and poor blood circulation (also known as peripheral arterial disease or PAD) slows down healing. In addition to that, foot deformities and trouble keeping blood sugar in check, and the risk of DFUs goes way up.

One big issue is that many people don't even realize they have a problem until it's too late. Since nerve damage reduces sensation, small cuts or blisters can go completely unnoticed. Over time, these minor wounds can get worse and become infected. To make matters worse, diabetes weakens the body's ability to fight infections, so once a foot ulcer starts, it can become really hard to heal (Apelqvist et al., 2017).

Certain foot conditions, like Charcot foot, also make things more complicated. When the bones in the foot shift, it changes how pressure is distributed, which can cause skin to break down more easily. Unfortunately, the longer someone has diabetes, the higher their chances of dealing with foot ulcers. That's why paying attention to foot care from the start is key (Boulton et al., 2018).

DFUs aren't just painful; they're actually life-threatening in some cases. If they get infected and don't heal properly, the risk of amputation increases. In fact, studies show that within five years, nearly 30% of people with DFUs don't survive—which is shockingly similar to some cancer survival rates (Armstrong et al., 2017). That's a scary number, but it highlights why early treatment is so critical.

Money is another huge concern when it comes to DFUs. The cost of treatment is not small—think about hospital stays, medications, surgeries, and long recovery periods. All of that adds up fast. A study by Zhang et al. (2020) actually found that people dealing with DFUs end up spending significantly more on medical care than those without them. And in places where access to specialized foot care is limited, the challenge is even bigger. It's not just about affording treatment—it's about getting the right treatment in the first place.

So, what's the smartest way to deal with DFUs? Honestly, there's no single answer. It takes a mix of different strategies. Keeping wounds clean, preventing infections, and making sure the affected foot isn't under too much pressure are all key steps. Managing underlying health issues, like PAD, also plays a big role. Armstrong et al. (2017) point out that using total contact casts can really help—by reducing pressure on the wound, they allow it to heal more effectively.

Infections are another major issue. If a DFU gets infected, things can go downhill fast. That's why cleaning wounds regularly, getting rid of dead tissue (a process called debridement), and using the right types of dressings can make a big difference (Lavery et al., 2016). But none of that will work if blood sugar levels are out of control. Studies show that people who stay on top of their glucose levels tend to recover faster and have fewer complications (Apelqvist et al., 2017). For those with PAD, doctors might need to step in and improve blood flow to the foot—otherwise even the best treatments would not be enough.

2.9 Complications of Diabetes Mellitus: Diabetic Foot Ulcer

Diabetic foot ulcers (DFUs) can lead to serious infections when they get worse, such as bone infections (osteomyelitis), and, in some cases, even the need for amputation (Del Core et al., 2018). What is even more alarming is that after an amputation, the chances of survival over the next five years are surprisingly similar to those seen in cancer patients. It's a harsh reality that many don't

realize, but it highlights just how critical early intervention and proper care really are. Early detection and intervention are crucial for reducing complications. Studies highlight that wound management, infection control, and glycemic stabilization are integral to improving DFU prognosis (Burgess et al., 2021; Michael et al., 2023; Liao et al., 2025).

A cross-sectional descriptive retrospective analysis of 37 patients analyzed mortality due to diabetic foot complications and revealed that the majority of patients had type 1 diabetic foot complications (n=29; 78.38%) according to Amit Jain's classification. Necrotizing fasciitis was the most common pathological lesion (n=12; 32.43%), followed by abscess (n=7; 18.92%). "The most common cause of death was septic shock (n=22; 59.5%), followed by acute myocardial infarction (n=8; 21.6%). The study concluded that the most common cause of death in diabetic foot patients in our study was septic shock (59.5%). The majority of patients (46%) die within a week of admission" (Jain & VIswanath, 2017).

A retrospective follow-up study was conducted in Ethiopia "to investigate the incidence of DFU and its predictors among newly diagnosed DM patients. A simple random sampling method was used to select 401 study participants. The findings revealed that 387 patients were followed retrospectively for a median follow-up time of 95 months. Overall, 66 (17.05%) patients developed DFU, with an incidence rate of 4 cases per 100 person-years of observation. Diabetic nephropathy (adjusted hazard ratio (AHR) = 2.37, 95% CI: 1.33–54.24), diabetic retinopathy (AHR = 5.56, 95% CI: 2.64–11.74), and increased body mass index (AHR = 1.13, 95% CI: 1.01–1.27) were found to increase the hazard of DFU" (Adem et al., 2020).

In Brazil, Fiore Scain et al. (2018) retrospectively carried out a longitudinal analysis of patients' data to ascertain how different foot changes in patients with type 2 diabetes relate to variables such as age, medical history, laboratory results, and treatment. The aim was to ascertain which of these variables would raise mortality risk in such patients. In this analysis, data was collected in a convenience sample of 918 medical records. The findings revealed that at 10 years, the cumulative mortality attributable to peripheral polyneuropathy was 44.7%, that attributable to peripheral artery disease was 71.7%, that attributable to both conditions were 62.4%, and that attributable to amputation was 67.6%. After multivariate analysis, the duration of nursing follow-up remained the only protective factor against death ($p < 0.001$) (Fiore Scain et al., 2018).

A descriptive retrospective study was performed in India to study the type of amputation performed in patients with diabetic foot complications. A total of 37 study participants were included in this study. The results revealed that the right foot was the most commonly involved foot, affecting 54.1% of the patients. The most common lesion was wet gangrene, affecting 37.8% of the patients. Minor amputations accounted for 83.8% of the cases, with toe amputation being the most common minor amputation. Almost all the foot amputations performed were type 1-foot amputations (simple). A total of 16.2% of patients required major amputation. The study concluded that diabetic foot is a leading cause of amputation. Our study revealed that wet gangrene

was the most common cause of amputation. Toe amputation is the most common type of amputation performed on diabetic feet (Jain & Tejasvitaa, 2019).

A cross-sectional study was conducted in Egypt "to estimate the prevalence of diabetic foot complications among patients at the Diabetic Foot Screening Clinic (DFSC) in Alexandria. The sample consisted of 1000 male and 1000 female consecutive adult patients with diabetes (≥18 years old) attending the Alexandria University Diabetic Foot Screening Clinic who were surveyed for history/presence of foot ulcers and/or amputations, skin/nail changes, joint mobility, sensory neuropathy and peripheral vascular disease (PVD) via the ankle brachial index (ABI). The results revealed that the majority of patients had type 2 diabetes (96.75%), with a mean age of 57.30 ± 10.47 years and a mean disease duration of 11.76 ± 8.26 years. The mean body mass index was 32.84 ± 6.31 kg/m2, with 29.55% being current or ex-smokers. Among these subjects, 4.4% had a past history of nontraumatic amputation (male: female: 6.2% vs. 2.6%, $p < 0.001$), 6.1% had a past history (10.3% vs. 7%, $p = 0.009$), and 8.7% had active foot ulceration (8.1% vs. 4.1%, $p < 0.001$) with a male preponderance. The prevalence of sensory neuropathy was 29.3% (M: F: 30.7%: 27.9%), and that of peripheral vascular disease (PVD) was 11% (M: F 11.8%:10.2%). Diabetic foot complications were associated with disease duration ($p < 0.001$), history of coronary artery disease ($p = 0.001$), stroke ($p = 0.009$), PVD ($p < 0.001$), laser photocoagulation ($p < 0.001$), sensory neuropathy ($p < 0.001$) and renal replacement therapy ($p < 0.001$). On multivariate analysis, diabetes duration, foot fissures, Charcot's foot, limited joint mobility, PVD and sensory neuropathy were independently associated with diabetic foot disorders. The study concluded that in Egypt, a mosaic of risk factors contributes to the high prevalence of diabetic foot disease in individuals with type 2 diabetes. These findings call for regular assessment of vascular, neuropathic and skin status to prevent these serious foot complications" (Assaad-Khalil et al., 2015)

A review article aims to discuss the 2 terms related to diabetic foot that can be used to increase awareness of this dangerous complication of diabetes (Apoorva & Jain, 2020). The term 'foot attack' is used to define an injury to the diabetic foot in a person suffering from neuropathy or peripheral vascular disease. Therefore, foot attack should be considered a medical emergency requiring immediate care. On the other hand, the term "diabetic foot storm" was derived on the basis of a new catalog of complications of diabetic foot disease, which aimed to increase awareness of the neglected complications. The term "storm" is used to describe a predicament in disease progression. In addition, this term is expected to have an impact on diabetic foot prevention plans and will provide a vital message to all on consequences a patient can have with diabetic foot, and there will be an emphasis on the prevention of this ignored complication. The review concluded that health care professionals play an essential role in preventing diabetic foot complications. Hence, in addition to educating patients, it is essential to educate them about this deadly disease. The familiarity of these two terms is likely to increase awareness of diabetic foot disease worldwide (Apoorva & Jain, 2020).

A descriptive retrospective analysis was conducted in India in 2021. The aim of this study was to analyze foot injuries that occurred at religious places. All diabetic foot patients who developed lesions after visiting religious places such as temples and mosques were included in this study. A total of 9 patients were included in this study, 55.56% of whom were males. A total of 88.89% of patients with foot lesions experienced injury at the temple. A total of 33.33% had bilateral foot lesions. The majority of them had noninfected wounds. One patient (11.11%) had ended up with amputation. In addition, the study concluded that injuries that can occur at religious places are preventable and that one should avoid presenting late, as they may end up in amputation. Different strategies need to be adopted by patients to prevent such complications, with one being the use of thick socks (Jain & Apoorva, 2021).

2.10 Quality of Life in Patients with Diabetes Mellitus and Diabetic Foot Ulcer

Diabetes Mellitus (DM) significantly reduces the quality of life due to chronic disease management, mobility limitations, and psychological distress. DFUs further impair daily activities and social engagement. Research indicates that integrating holistic care approaches, including psychological counseling and social support, enhances patient outcomes (Connell et al., 2021).

DM adversely affects QoL through its chronic nature and associated complications. Psychological distress, i.e., anxiety and depression, is prevalent in diabetic patients and is one of the most important determinants of low QoL. Appropriate self-management of diabetes in terms of adherence to drugs, diet control, and regular physical exercise is also a crucial factor in improving QoL. Numerous interventions have been attempted to enhance QoL in diabetic patients (Ahmad & Joshi, 2023).

Diabetes Mellitus (DM) is a chronic disease that is a growing problem in many areas of the world, including Middle Eastern countries like Jordan. The literature review in this article analyzes DM's epidemiology and models of care in Jordan based on evidence of recent scholarly work such as that of Characterizing the Type 2 Diabetes Mellitus Epidemic in Jordan Up to 2050 (Yousef et al., 2020).

Yousef et al (2020) indicated that the prevalence of DM, particularly of T2DM, has grown exponentially throughout the last two decades. The estimated 14.0% of prevalence of T2DM in 1990 had reached up to 20.6% by 2050. The utilization of a mathematical modeling framework estimated historical trends and trends that were anticipated, concluding that there is tremendous association of increasing levels of obesity with increasing levels of prevalence of T2DM.

Additional studies concur with these findings, emphasizing that Jordan's population is also experiencing a dramatic surge in DM prevalence. The primary risk factors that are driving the epidemic of diabetes in Jordan include obesity, inactivity, diet, and increasing older age (Yousef et al., 2020). Dietary transitions and urbanization have resulted in increased caloric intake and decreased physical activity, linked to higher obesity rates, a primary indicator of diabetes.

According to Abdel-Rahman et al (2018), gender and income also contribute to diabetes prevalence in Jordan. Higher diabetes and obesity levels have been reported among women versus

men have been indicated by earlier research, most likely owing to levels of activity that are too low and to beliefs that discourage outdoor activity that are sociocultural. The lower income groups also bear a greater burden, suggesting health care availability and diabetic educational variations.

2.11 The Health Care System in Jordan, Diabetes Mellitus and Diabetic Foot Ulcer

The Ministry of Health of Jordan has developed plans to control non-communicable diseases, including diabetes (Ministry of Health, 2021). These strategies focus on early detection, lifestyle interventions, and integrating diabetes management into primary healthcare services. Additionally, the Jordanian Nursing Council (JNC) plays a vital role in improving nursing education, clinical training, and research related to diabetes care (JNC, 2022). However, its impact is often underrepresented in policy discussions, limiting its influence on national healthcare strategies.

Public health interventions targeting obesity and unhealthy lifestyles are essential in combating the diabetes epidemic in Jordan. Yousef et al. (2020) also suggest active health interventions within the community focusing on lifestyle and obesity to curb diabetes epidemic. Social programs that encourage healthy lifestyle through health educational campaigns have been effective elsewhere within Middle Eastern countries and need to also be implemented within Jordan. Moreover, primary healthcare facilities remain a critical component of diabetes care in Jordan. These centers provide essential services such as blood glucose monitoring, patient education, and early screening for complications. However, their effectiveness is constrained by insufficient healthcare funding, poor adherence to treatment guidelines, and limited access to specialized diabetes care (Ajlouni et al., 2019).

Despite advancements, the financial burden of diabetes in Jordan is substantial, impacting both healthcare costs and national productivity. Without stronger institutional support, increased investment in diabetes prevention, and enhanced healthcare infrastructure, the management of diabetes will continue to face significant obstacles (Ong, 2023).

2.12 Diabetes Mellitus and Diabetic Foot Ulcer in Jordan

Ajlouni et al. (2019) indicate that there has been a dramatic rise in diabetes mellitus in Jordan over the last two decades. The analysis employed four national surveys in 1994, 2004, 2009, and 2017 to determine that there was a significant rise in the prevalence of diabetes in individuals within over 25years and above. The age-standardized prevalence was 13.0% in 1994 compared to 23.7% in 2017, indicating a steeply increasing trend between 1994 to 2009 after which it slowed slightly. The research also indicated that the surge in cases of diabetes was more dramatic in men, a more-than-doubled prevalence of over 32.4% in 2017. In women, there was a more incremental rise, from a prevalence of 12.3% in 1994 to one of 18.1% in 2017.

The research attributes such advances to lifestyle changes such as reduced physical activity and dietary patterns, combined with higher life expectancy and more sophisticated diagnostic tools. Tabanjeh et al. (2020) compared diabetic foot ulcers (DFUs) in patients in Jordan and established a range of key risk factors that were linked to their recurrence. The study of 141 diabetic patients was carried out over two years at the "National Center for Diabetes, Endocrinology, and Genetics" in Amman, Jordan. Among these patients, 76 (53.9%) developed recurrent ulcers, 54 (38.3%) did not develop ulcers, and 11 (7.8%) developed chronic ulceration.

The overall two-year recurrence was high at 58.5%, consistent with international evidence that places DFU recurrence high on the list of challenges in managing diabetes. The analysis also identified osteomyelitis and foot deformity to be the most significant independent indicators of recurrent ulceration, patients having these complications being 14 times and 8 times more likely, respectively, to develop recurrent ulcers. Other vascular calcification indicators, osteopenia, and poor diabetic control were also found to be linked to higher recurrence. These findings underscore the need for early detection and treatment to avert recurrence of ulcers, given that DFUs are a key cause of lower-limb amputations and a major cause of diabetic patients' mortality and morbidity. The study also highlights the importance of overall foot care and surveillance in diabetic patients, even more in patients with a history of complications. In view of the fact that around 87% of patients in the study presented with uncontrolled diabetes (HbA1c > 7%), Tabanjeh et al. (2020) stressed that better glycemic control is one of the preventive measures in DFU.

Behavioral and biologic aspects also seemed to be a determining factor in recurrence, smoking, obesity, and duration of diabetes being other risk indicators. Addressing these risk factors would be in a position to curtail healthcare expenses and enhance diabetic patients in Jordan's quality of health. The analysis was done using a systematic random sample of 1,000 diabetic patients that attend the "National Center for Diabetes, Endocrinology, and Genetics" in Amman, Jordan. The analysis found that 4.6% of the study population exhibited active DFUs, whereas 14.9% exhibited sensory neuropathy, 7.5% exhibited lower limb ischemia, and 1.7% exhibited amputations (Bakri et al., 2012).

According to Ababneh et al. (2019), foot deformity is a common complication in diabetic patients in Jordan that is a primary reason for diabetic foot ulcers (DFUs). In a cross-sectional analysis of 1,000 diabetic patients attending the "National Center for Diabetes, Endocrinology, and Genetics" in Amman, the researchers estimated the prevalence of foot deformities of hallux valgus (17.4%), claw/hammer toes (16%), high metatarsal heads (14.2%), limited joint mobility (9.4%), pes cavus (3.2%), Charcot foot (2.1%), and amputations (1.7%).

The study established high associations between foot deformity and various risk factors, including age, gender, footwear, and diabetic complications such as neuropathy and retinopathy. Specifically, hallux valgus was linked to increasing age and ill-fitting shoes, while Charcot foot was highly linked to ill-fitting shoes, poor glycemic control, hypertension, and neuropathy. The authors noted that most of these deformities arise from motor neuropathy, resulting in muscle weakness in the foot, altered foot anatomy, and altered distribution of pressures that put patients at risk of ulcers.

The study underscores preventive treatment and early screening to limit foot abnormalities and consequent ulcerations. As many of these ailments can be controlled using proper footwear, physical therapy, and control of blood sugar, the researchers support educational programs that focus on foot care to raise awareness in diabetic patients. Further, they also support inclusion of podiatric examinations in regular treatment of diabetes, particularly in high-risk patients. Preventive measures such as foot checks at regular intervals, educating patients in footwear options, and use of therapeutic shoes can possibly cut down on diabetic foot complications. These findings support international guidelines in stressing that there is a need for multidisciplinary diabetic management involving endocrinologists, podiatrists, and orthopedic surgeons to deliver integrated foot care. Khawaja et al. (2018) carried out a comparative analysis on diabetic peripheral neuropathy (DPN) prevalence among individuals with type 2 diabetes mellitus (T2DM) in Jordan. The cross-sectional survey of 1,003 diabetic individuals within the "National Center of Diabetes, Endocrinology, and Genetics" utilized the Michigan Neuropathy Screening Instrument (MNSI) to screen for DPN. The findings of the analysis were that 39.5% of individuals had DPN, of which numbness (32.3%) occurred most frequently, followed by pain on walking (29.7%). The findings reinforce how much of a burden is brought by DPN along with its complications, i.e., infection of the foot, ulceration, amputations. The article underscores the necessity of intensified programs of screening to detect susceptible individuals and advocates multidisciplinary management strategies taking into view vascular and metabolic parameters that contribute to DPN. With such a high correlation between diabetic complications and neuropathy, the researchers support a multidisciplinary team that consists of neurologists, endocrinologists, and primary care providers. Patient education on foot care, lifestyle changes, and periodic neurologic examinations is also advised to prevent complications of neuropathy. Such observations agree with international studies that DPN is a powerful indicator of diabetic morbidity and mortality, hence preventive treatment to restrict its impact is a need of high priority.

The study of Ajlouni et al. (2019) explored partnership in improving health services and medical education in Jordan, specifically in cooperation between healthcare institutions and healthcare organizations. The work underscores that there is a need to bridge medical education to public health interventions in order to address the growing burden of chronic disease in the face of diabetes. By encouraging cooperation between hospitals, universities, and government institutions, the work argues that healthcare systems can provide better results in patients in terms of evidence-based interventions, human resource development, and more accessible specialist services.

The study also underscores the need to use technology to support medical education and training, particularly in treatment of diabetes, in which professional development is a continuous process to enhance clinical results. The findings also indicate the need to build institutional relationships to enhance healthcare provision in Jordan. With a combination of scholarly knowledge and healthcare resources, healthcare practitioners can use more effective disease control and prevention strategies. The study is in support of integrated models of healthcare that link primary, secondary, and tertiary healthcare services to deliver a smooth continuum of

treatment to diabetic patients. The researchers also support more funding of medical research and innovations to produce context-relevant solutions to control diabetes and other chronic conditions. Given the increasing trend of diabetes in Jordan, they advised that healthcare policy must follow a more comprehensive diagnostic process to deliver speedy and accurate diagnosis of diabetes.

AlAyed et al. (2016) conducted a study to assess diabetic foot ulcers, foot-at-risk status, and related risk factors in diabetic patients in Jordan. The subjects of this study were 1,000 diabetic patients of the "National Center for Diabetes, Endocrinology, and Genetics" (NCDEG) in Amman, Jordan. The results of the study showed that 5.3% of patients had active foot ulcers, whereas 17.2% of patients had feet that were at risk of ulceration. Additionally, 1.7% of participants had amputations. The researchers found that there were many risk variables highly associated with foot ulcers such as loss of protective sense ($p < 0.000$), loss of vibratory sense ($p < 0.039$), and vascular insufficiency ($p = 0.02$). The foot ulcers in the study were measured using Wagner's system of categorization, which found that most of the ulcers were in their initial stages of severity, indicating that there is a potential for early treatment to prevent progression

Additionally, they also campaigned for national diabetic foot care guidelines in diabetic patients to cut amputations and overall enhancement of quality of life. The outcomes agree with international recommendations that put a high value on early diagnosis and complete foot care in diabetic control.

2.13 Jordanian Nurses in the Prevention and Control of Diabetes Mellitus and Diabetic Foot

Jordanian nurses take an important role in delivering patient-centered care to patients with DM, specifically in preventing, managing, and educating patients. The JNC (2017) reported that in managing diabetic patients, evidence-based, accepted interventions need to be utilized to facilitate behavior change and disease progression management. The areas of their work include patient examinations, diabetic self-management education, adherence to treatment regimen, and glycemic control.

Moreover, nurses facilitate patients to become active participants in their treatment, which has led to better clinical results. By providing individualized guidance and education, patients are better able to manage their disease (Abu Al-Halaweh et al., 2015). Such a multidisciplinary treatment is in conformity with international standards of treatment, offering integrated support to patients in Jordan.

Patient education is a basic pillar of diabetes management. Nurses provide patients on a regular basis education on crucial areas of self-management that include blood glucose self-monitoring, medication adherence, dietary adjustment, and physical activity. Patient education offered by nurses has been repeatedly proven to positively impact self-management behavior, improving blood glucose control and reducing complications (Alhalaiqa et al., 2018; AbuRuz, 2019).

Abu Al-Halaweh et al. (2015), patients who underwent structured guidance by nurses showed higher treatment program adherence and higher knowledge of the necessity of lifestyle changes. Such outcomes elevate patients' quality of life in cases of diabetes but also decrease the total burden of the healthcare system. Furthermore, nurses typically apply culturally adapted training strategies to meet the particular needs of patients in Jordan, concentrating on social and cultural variables that impact health behavior.

The execution of national diabetic treatment guidelines is also one of the primary responsibilities of Jordanian nurses. The National Jordanian Experts Consensus on Diagnosis and Treatment of Prediabetes is a document that consists of evidence-based guidance regarding prediabetes and diabetic diagnosis, screening, and treatment (Hammad et al., 2021). Nurses should apply these rules in their professional work to treat patients in a standardized manner of high quality.

Also, regular checks for high-risk patients are done by nurses, enabling prediabetes and diabetes to be diagnosed earlier. Early diagnosis allows for quick action that can forestall or delay problem initiation. Nurses also check patients' adherence to treatment procedures and report to doctors to maintain treatment continuity and adherence to national standards (JNC, 2017).

Despite their key function, Jordanian nurses face a range of challenges and barriers in providing quality diabetes treatment. One of their key challenges is a scarcity of nursing staff, resulting in high ratios of patients to nurses and fewer hours of one-on-one treatment (Alhalaiqa et al., 2018). The problem is most acute in rural and marginalized areas, where there is a scarcity of healthcare resources.

In addition, socioeconomic status and culture also impede provision of diabetes education. The patients also suffer from poor health literacy or refuse to adapt to lifestyle modifications, making it challenging for nurses to facilitate self-management behavior (AbuRuz, 2019). All these challenges are exacerbated by poor provision of continuing professional development to nurses, hence their inability to be up to date with advances in managing diabetes (Alhalaiqa et al., 2018).

Nurses in Jordan work in close cooperation with other healthcare professionals to deliver integrated treatment of DM. Multidisciplinary groups of physicians, dietitians, and social workers deliver integrated treatment to address diverse needs of DM patients. The multidisciplinary approach ensures that patients receive integrated treatment such as blood glucose management, incorporating psychological, dietary, and social aspects of disease (Andersen et al., 2023).

Community-based programs have also been shown to be effective avenues of diabetes care and prevention. The nurses also have a key role to play within programs where workshop activities, health checks, and follow-up care are done by them. The programs have been shown to have tremendous success in increasing diabetes awareness and its associated risk factors among poor and rural populations (Hammad et al., 2021).

2.14 Nurse Training on Diabetes Mellitus and Diabetic Foot Ulcer in Jordan

Training and educating nurses in Jordan are guided by national programs and frameworks that facilitate enhancing healthcare providers' competencies. The Jordanian Nursing Council established elaborate standards of diabetic health nursing that are centered on evidence-based practices and culturally relevant methods of managing diabetes (JNC, 2017). The standards provide a formal framework for nurse training that encompasses areas of educating patients, support of self-management, and managing diabetic complications.

Additionally, the "National Center for Diabetes, Endocrinology, and Genetics" (NCDEG) is tasked with offering training programs for healthcare providers, including nurses (National Center for Diabetes, Endocrinology, and Genetics, 2025). The programs help to build knowledge of pathophysiology of diabetes, treatment regimen, and patient counseling (Hammad et al., 2021). Nurses that take such programs report that their self-assurance in offering integrated diabetes care, such as glycemic control, dietary guidance, and complications prevention, is increased.

Research indicates that training programs for nurses have a positive impact on the quality of diabetes care in Jordan. For example, Abu Al-Halaweh et al. (2015) found that nurses who underwent structured training were better equipped to educate patients on self-management practices, leading to improved glycemic control and reduced complications. The study highlights the importance of continuous education in building nurses' capacity to address the dynamic challenges of diabetes management.

Training also prepares nurses to be proactively engaged in using national diabetes guidelines. Hammad et al. (2021) found that educated nurses in using such guidelines would be more likely to use active strategies in diabetic and prediabetic patients for early detection, risk assessment, and lifestyle advice. This is in keeping with global best practices, reinforcing the crucial role of training in standardizing treatment of diabetes.

Despite the benefits of existing training programs, various challenges impact their effectiveness in Jordan. One of such challenges is resource limitation in that there is a lack of sufficient funding and infrastructure that restricts the scope of training programs. Alhalaiqa et al. (2018) established that many of the nurses, particularly in rural and distant areas, lack exposure to up-to-date learning resources and infrastructure, inhibiting their professional growth.

Nurse training programs in DM in the Middle East are developed to address the unique challenges of the disease, i.e., resource limitation and cultural issues. There are different countries that established official programs and standards to enhance the competency of nurses in managing patients with diabetes (Alotaibi et al., 2016).

In Jordan, diabetic health nursing standards that are evidence-based and culturally adapted have been developed by the Jordanian Nursing Council (JNC, 2017). The "National Center for Diabetes, Endocrinology, and Genetics" (NCDEG) also conducts continuing education in preventing diabetes, advanced glycaemic surveillance, and managing complications (Hammad et al., 2021).

Nurses that underwent training in diabetes care exhibit higher competency in educating patients, blood glucose control, and managing diabetic complications. In Jordan, Abu Al-Halaweh et al. (2015) established that educated nurses facilitated improved self-management behavior in diabetic patients to a large extent. The nurses facilitated empowerment of patients to take control of their health, resulting in improved blood sugars control and fewer complications.

Cultural factors also play a significant role in determining the effectiveness of nurse education. Nurses must work around cultural and social norms that impact health behavior, such as dietary behavior and beliefs around physical activity. Cultural nuances around these aspects of health behavior are not always taken into account in training programs, creating gaps in patient education and engagement (Alotaibi et al., 2017).

Certain areas of diabetic management, such as diabetic foot management, remain overlooked in educational curricula. One such research that measured nurses' knowledge of diabetic foot management in Jordan indicated that there was a high rate of poor knowledge, at 55% of participants (Al-Domi et al., 2020).

2.15 Nurses' Knowledge Toward Diabetic Foot Ulcer

Effective management of DFUs requires diverse areas of knowledge ranging from preventive measures, modes of assessment, preventive measures, and treatments. The nurses encounter diabetic patients for the first time; therefore, awareness of foot complications warning signs is of fundamental importance to them (Boulton et al., 2018).

Research indicates that there is disparity of nurses' knowledge regarding DFUs. A nurses' survey by Chiwanga and Njelekela (2015), in Tanzania, indicated that only 20% of nurses had appropriate diabetic foot care knowledge, suggesting that there is need for targeted educational interventions.

Al Alawi et al. (2023) assessed the level of management knowledge of diabetic foot care among medical students attending Tabuk University, Saudi Arabia. The cross-sectional survey included 301 study participants, assessing the level of management knowledge of the risk factors, preventive measure, and management strategies of diabetic foot. The level of management knowledge by the medical students was found to be moderate, with an average management level of 52.7 out of 68. The highest-scoring topic was examination of the foot (85%), whereas the lowest-scoring topic was application for preventing foot complications (72.5%). Remarkably, it was found that academic year, previous training, and experience teaching diabetic patients had an effect on the level of knowledge. Women students and those previously trained in care of the diabetic foot had greater proficiency than those not so trained (Al Alawi et al., 2023).

The study emphasizes the need for increased medical education regarding diabetic foot care, considering the increased prevalence rate of diabetes in Saudi Arabia. The authors suggest introducing increased practical sessions and workshops as part of the medical course work so that students' competence in managing diabetic feet can be increased. The study also stresses early screening and treatment so that diabetic ulcers and subsequent amputations may be avoided. The

findings agree with other studies showing that the level of healthcare professionals' knowledge on diabetic foot care has always been found lacking, causing poor treatment outcomes and delay in diagnosis. Longitudinal studies must measure the impact of well-structured educational interventions on the ability of healthcare practitioners to address diabetic foot issues (Al Alawi et al., 2023).

In Bangladesh, a descriptive study was conducted by Das (2020) to evaluate the knowledge, attitudes and practices of nurses towards the diabetic foot, at the BIRDEM (Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine, and Metabolic Disorders). A total of 207 Senior Staff nurses or nurses working in the surgical wards or the outpatient departments (OPDs) were consecutively included in the study. Non-probability convenient sampling was used and a pre-structured questionnaire was used to assess the knowledge, attitudes, and practices of nurses about diabetic foot care. The findings revealed that About 50% of the respondents were 40 or > 40 years old with the mean age of the respondents being 37.4±10.4 years. The respondents were predominantly female (80%) married (75.4%). Approximately 80% of the respondents had a diploma (basic nursing degree) degree alone, 14.5% obtained a graduate (BSc Nursing) degree as well. Over half (51.1%) of the respondents had > 10 years of professional experience with average years of experience being 14.6 ± 0.7 years, but two-thirds (68.1%) had < 5 years and only 13% had > 10 years of wound-care experience. Nearly 40% had specific training on wound care. One-third (34.3%) of the nurses were placed in Internal Medicine Unit, 33.8% in Surgery Unit, 14.4% in the Emergency Unit. Over two-thirds (68.6%) of the nurses were service nurses, 18.4% were supervisors, 3.9% were intensive care nurses and 8.2% were polyclinic nurses. The respondent's level of knowledge was evaluated in terms of a Likert scale of 0 – 4 (as described in the Methods section). Accordingly, 30% of the respondents had poor, 8% fair, 47.1% average 2.9% satisfactory, and 12% highly satisfactory level of knowledge (Das, 2020).

In Jordan, a cross-sectional, descriptive design study was conducted in 2020 by Al-me`ani and Al-Wahsh (2020) "to assess nurses' diabetic foot ulcer knowledge of DFU at hospitals in Jordan. In addition, to assess the relationships between nurses' demographic characteristics and DFU knowledge, this study was carried out in nine selected government hospitals of the Ministry of Health (MOH) located in the southern, middle, and northern regions of Jordan." Data was collected from 256 nurses using the convenience sample technique. The researcher used an instrument entitled "The Knowledge, Attitudes, and Practices of Diabetic Foot Ulcer Questionnaire (KAP-DFUQ)", which contains 34 items. The result showed that "half of the participants had an inadequate level of knowledge (55%; n = 141) toward DFU. The knowledge of nurses was affected by the following variables: age and working area (OR =.107, p=.040)" (Al-me`ani & Al-Wahsh, 2020). The study suggests that Healthcare organizations should have a national plan to encourage nurses to participate in theoretical and practical DFU training programs, to improve their knowledge of DFU (Al-me`ani & Al-Wahsh, 2020).

A qualitative study design conducted in Tobago is focused on "assessing the knowledge, attitude, and practice of adults with diabetes on foot ulcers and foot care in Tobago using a qualitative exploratory design. Purposeful sampling technique was used to recruit 20 participants. The findings from the study revealed that the majority of participants had poor knowledge regarding DFU but exhibited awareness about foot care, especially on foot cleaning and inspection, preventing irritation after washing, appropriate footwear, and not walking barefooted. The participants had good attitudes and practices of foot care despite their poor knowledge of DFU. However, participants reported inadequate health education on DFU and foot care from healthcare personnel. There should be improved health education, information, and communication on DFU and foot care centered and tailored to the understanding of people living with diabetes." (Adeyemi et al., 2021)

In Australia, a quasi-experimental pre-test/post-test study design was carried out by Schoen et al. (2016) "to determine knowledge of national guidelines for diabetic foot assessment and risk stratification by rural and remote healthcare professionals in Western Australia and their implementation in practice. Two hundred and forty-six rural and remote healthcare professionals were involved in this study. Healthcare practitioners' knowledge, attitudes, and practice of diabetic foot assessment, diabetic foot risks, risk stratification, and use of the 2011 National Health and Medical Research Council Guidelines were investigated with an electronic pre-test survey. Healthcare professionals then undertook a 3-h education and training workshop before completing the electronic post-test knowledge, attitudes, and practice survey. The results of this study indicate that two hundred and forty-six healthcare professionals from two rural and remote health regions of Western Australia participated in training workshops. Monofilaments and diabetes foot care education brochures, particularly brochures for Aboriginal people, were reported as not readily available in rural and remote health services. For most participants (58 %), their post-test knowledge score increased significantly from the pre-test score. Use of the Guidelines in clinical settings was low (19 %). The healthcare professionals' baseline diabetic foot knowledge was adequate to correctly identify the high-risk category." However, stratification of the intermediate-risk category was poor, even after training (Schoen et al., 2016).

A randomized controlled trial study was carried out in China in 2018 by Chen et al. (2018) among 200 nurses (100 nurses in the intervention group and 100 nurses in the control group). The purpose of this study is to assess the effectiveness of a diabetic foot care workshop on KAP. The methods that were used in this study: the intervention group received a 4-week diabetic foot care session, while the control group received no intervention. KAP was measured using structured questionnaires. Based on the results of this study, the nurse's levels of knowledge and the intervention group scores improved from 60% (pre-test) to 88% (post-test), while the control group presented no significant change. In addition, there were positive attitudes amplified from 65% (pre-test) to 90% (post-test) in the intervention group. Also, the nurse's practice of diabetic foot care enhanced from 55% (pre-test) to 82% (post-test) in the intervention group. Nevertheless, the

study concluded that the workshop significantly enhanced nurses' KAP, demonstrating the value of hands-on training in diabetic foot care education (Chen et al., 2018).

A cross-sectional study was conducted in Pakistan in 2019 by Khan et al. (2019), with 120 nurses from public and private hospitals. The purpose of this study is to evaluate the long-term impact of a diabetic foot care training program on nurses' KAP. The three-day diabetic foot care training session was followed by assessments of the nurses' knowledge, attitudes, and practice before, during, and three months after the program. The results of this study reveal a significant increase in nurses' knowledge from 50% (pre-test) to 85% (post-test), and it remained at 80% after three months. Also, positive attitudes improved from 60% (pre-test) to 90% (post-test) and persisted at 85% after three months, reported the same result in this study. Additionally, nurses' practice improved from 45% (pre-test) to 75% (post-test) and remained at 70% after three months (Khan et al., 2019).

A mixed-methods study was carried out in Brazil in 2020 by Martinez et al. (2020) among 100 nurses from community health centers. The study aims to assess the effectiveness of a blended learning program on nurses' KAP in diabetic foot care. A 5-week blended learning program consisting of both online modules and in-person workshops was implemented. Surveys and focus groups were used to evaluate KAP. According to the results, the nurse's knowledge score increased from 55% on the pre-test to 90% on the post-test. In contrast, the percentage of positive attitudes increased from 65% before the test to 95% after it. Furthermore, the nurse's practice grew from 50% before the test to 85% after it (Martinez et al., 2020).

In 2022, a cluster randomized controlled trial was carried out in Australia with 250 nurses from 10 institutions. The purpose of this study is to evaluate the effects of a diabetic foot care education program on nurses' KAP over six months. A diabetic foot care education program was conducted for six months. At baseline, three months, and six months, KAP was evaluated. According to our findings, nurses' knowledge scores increased from 60% at baseline to 92% after six months. Conversely, the findings showed that nurses' positive attitudes improved from 70% (baseline) to 94% (6 months). According to the data, nurses' practice levels increased from 55% (baseline) to 88% (6 months). A study concluded that the program significantly improved nurses' KAP, with sustained effects over 6 months (Brown et al., 2022).

Ng et al. (2020) conducted research to identify awareness and perceptions of foot care in diabetes at secondary level of healthcare in Malaysia. They used a validated tool to survey 101 nurses on risk factors, characteristics of ulcer, complications of ulcer, and treatments for foot complications of diabetes. Findings revealed that foot care awareness of 57% of the nurses was poor of which 72% of them did poorly on complications of ulcer. Despite the absence of adequate knowledge, 49.5% of the nurses expressed having a good attitude towards caring for feet in diabetes while 79.3% of them believed that caring for foot ulcers in diabetes was time-consuming. Most of the nurses' knowledge was from their peers rather than through in-service or through formal training (Ng et al., 2020).

The study re-emphasizes that adequate education and training of nurses is needed given their crucial contribution to foot care in patients with diabetes. There must be more intensive workshops

and methodical trainings to enhance foot care competency of nurses. They also highlight the importance of incorporating diabetic foot care into routine nursing curricula and continuous professional development programs. The findings align with global research indicating that a lack of knowledge among healthcare providers contributes to delayed diagnoses and poor patient outcomes (Ng et al., 2020).

There were 207 nurses with experience of more than one year in caring for foot in diabetes who took part in research through a structured questionnaire to identify their awareness level of causative factors of DFU, their management, and prevention methods. Results indicated that only 12% of the nurses expressed a high level of satisfactory knowledge, while 47.1% expressed average knowledge, while 30% expressed poor knowledge. Although having only a moderate level of understanding, majority of the nurses expressed a good attitude towards enhancing their diabetic foot care knowledge (Ng et al., 2020).

The study identifies intensive modules of training to enhance competency in caring for patients with diabetes foot for nurses. As DFUs account for much of hospital admission in patients with diabetes as well as amputation in these patients, authors believe that inclusion of practice guidelines in curricula for nurses based on evidence would be beneficial. The research identifies on-going professional practice to make nurses competent to prevent, assess, and provide care for complications of foot in diabetes in their practice (Ng et al., 2020).

Implementing structured educational programs has also shown promise to improve nurses' competency levels regarding managing DFU. A range of reasons can contribute to nurses' deficits of knowledge. Some of these reasons are lack of experience of continuing education, availability of only limited amounts of time within practice, and lack of procedural guidelines on managing DFU (Abate et al., 2020).

To address such deficits, health institutions must give top priority to ongoing education and training on DFU prevention and management. The integration of evidence-based guidelines within nurses' curricula and frequent workshop attendance would ensure that nurses remember what is learned and can apply it accordingly (Lopez & Cleary, 2019).

2.16 Nurses' Attitudes Toward Diabetic Foot Ulcer

Nurses with a positive attitude towards the management of DFU are more dedicated to caring for patients and to evidence-based practice. Kumarasinghe et al. (2017) found that positively oriented nurses towards patients of DFU would be more likely to apply multifaceted preventive strategies such as educating patients and foot examinations on a regular basis. Their attitude is credited to fewer complications, fewer amputations, and better overall results. Such positively oriented nurses also assist patients in adhering to self-management practices, thereby improving treatment adherence.

Negative attitudes of nurses can override efforts to manage DFU. Wui et al. (2020) noted that a high percentage of nurses perceive treatment of DFU to be time-consuming and boring. Such a perception is likely to result in resistance to carry out a full assessment or intervene. Similarly, a

deficiency in self-confidence owing to poor knowledge is likely to result in avoidance of hard cases, eventually resulting in a delay in crucial interventions. Negative attitudes also manifest in low empathy, compromising patient-nurse relationships and likely discouraging patients to pursue or continue treatment.

In 2024, 200 nurses from academic medical institutes participated in a quasi-experimental study. This study was designed to evaluate nurses' performance in simulation-based diabetic foot care training. A four-week diabetic foot care training program was conducted using simulation. The nurses' knowledge, attitudes, and practice were assessed before and after the program. The results of the study found that the nurses' knowledge scores were 70% before the training program, while their' knowledge scores increased significantly after the training program. On the other hand, the nurses' attitude scores increased significantly, reaching 80% in the pretest and then increasing to 97% in the posttest. In addition, the nurses' practice scores were recorded, which increased significantly, with the post-test scores being 92% compared to the pre-test scores of 65% (Smith et al., 2024).

2.16.1 Several interconnected factors influence nurses' attitudes toward DFUs:

1. Education and Training

Nurses who receive a high level of training in preventing and managing DFU exhibit more positive attitudes. Kumarasinghe et al. (2017) established that 91.2% of nurses expressed that they did not receive formal wound care education, a factor that highly impacted their confidence and attitudes. There is a need for continuing professional development to equip nurses with knowledge and competencies that allow them to provide high-quality DFU care.

2. Experience

Clinical experience in patients of DFU can affect the attitudes of nurses. Working in cases of successful results, i.e., closure of chronic wounds or complications avoided, yields optimistic attitudes. Working in cases of chronic wounds day after day or poor prognosis without enough support, though, can produce frustration and pessimistic attitudes (Feng & Yu, 2024).

3. Work Environment

Supportive work environments that enable team working, provide adequate resources, and accommodate continuing education positively impact nurses' attitudes. Organizations that value the crucial role of nurses in managing DFU enable a professional job satisfaction and motivation (Mabona et al., 2022).

4. Cultural and Institutional Factors

Cultural attitudes towards diabetes complications, as well as institutional policy, can dictate nurses' approaches to managing DFU. Nurses in resource-limited settings often face challenges that can be harmful to their attitudes, such as a lack of specialist equipment or unavailability of interdisciplinary consultation (Mafusi et al., 2024).

The attitudes of nurses also impact patients with DFUs in a quantifiable manner. Positive attitudes result in active treatment, i.e., early detection of ulcers, timely intervention, and effective patient education. Such interventions are crucial in preventing serious complications and hastening healing. Negative attitudes, on the other hand, result in neglect or delay in treatment, causing deterioration of ulcers, risk of infection, and amputation (Abate et al., 2020).

2.17 Nurses' Practices Toward Diabetic Foot Ulcer

Nurses play a key function in preventing DFUs through regular screenings and patient education. Foot hygiene, wearing of appropriate footwear, and check-up every day should be educated to patients to prevent ulcers. Kavitha et al. (2014) established that foot ulcers were minimized to a large extent by patient education provided by nurses. Such preventive methods are responsible for preventing the formation of DFUs and complications associated with it.

Nurses are trained to perform in-depth foot examinations to identify initial warning signals of DFUs, including coloration of the skin, formation of a callus, or loss of sensation. The use of evidence-based tools of measurement, including Wagner's Classification System, has been encouraged to standardize procedures and ensure consistency (Chiwanga & Njelekela, 2015). Early detection is best facilitated by regular checks to enable early intervention that prevents ulcers from developing to more advanced stages.

Once a diagnosis of a DFU is established, wound care is assumed by nurses. This includes wound cleaning, applying dressings correctly, and looking for signs of infection. Infection control is also a primary function, with antibiotic treatment when necessary and educating patients in wound hygiene maintenance (Habboush et al., 2023).

2.18 Factors Influencing Nurses' Knowledge, Attitudes, and Practices on Diabetic Foot

Education, clinical exposure, institutional support, and cultural influences define competencies of nurses in managing DFU. Enhancement of these areas results in better quality of care. Sung et al. (2016) highlighted that mentoring programs and policy programs have a significant impact on diabetic care in nursing.

A longitudinal study was conducted in South Korea in 2023 among 300 nurses from tertiary care hospitals. Assessing the long-term impact of an online diabetic foot care program on nurses' KAP is the aim of this study. An online diabetic foot care program was conducted over 12 weeks. The results showed that after 12 weeks, nurses' knowledge ratings rose from 65% at baseline to 93%. However, after 12 weeks, nurses' positive attitudes increased from 75% at baseline to 96%. Additionally, after 12 weeks, nurses' practice increased from 60% at baseline to 90%. The study concluded that the training was highly effective based on the data, showing a significant improvement in nurses' KAP at both 6 and 12 weeks (Lee et al., 2023).

Ababneh et al. (2021) also translated and assessed the reliability of Arabic translations of diabetic foot psychosocial scales, mindful of the need of suitable cultural assessments among Arabic speakers. However, "the objective of the study was to translate and cross-validate five scales, viz., Foot Care Confidence Scale (FCCS), Foot Care Outcomes Expectations Scale (FCOES), Patient Interpretation of Neuropathy Scales (PINS), Neuropathy-specific Quality of Life Scales (NQOLS), and offloading Visual Analog Scales (VAS)" (Ababneh et al., 2021). The translation process followed a systematic process that involved forward and backward translations, review by expert panels, and cultural adaptation. The reliability of the scales was validated on a sample of 90 diabetic foot ulcer patients in Jordan, where most of the scales had good internal reliability ($\alpha = 0.74$-0.91), but there were lower reliability values on some of the scales such as PINS "self/practitioner blame" and "acute ulcer onset" scales ($\alpha = 0.57, 0.49$), indicating that there is scope for optimization.

The study emphasized that there is a need to obtain a valid and reliable set of diabetic foot treatment measurement tools for patients of Arabic descent. The researchers also emphasized that self-efficacy and outcome expectations are two of the most important psychosocial variables that impact foot care behavior and ulcer prevention. The researchers also recommended that these scales be used in future studies to ascertain diabetic foot management behavioral and psychological aspects to enable better patient education and clinical interventions. The findings also indicated that there was a need for more to be done to calibrate the consistency and validity of the scales, in particular for subscales that presented lower consistency estimates. The work is a crucial step towards better diabetic foot disease assessment and management in Arabic patients using culturally adapted psychosocial tools

Shah et al. (2021) explored the demographic profile of diabetic foot ulcers (DFUs) to ascertain the socio-demographic risk factors of this condition. The research was conducted in a hospital in India, Yenepoya Medical College Hospital, in 75 diabetic patients with foot ulcers. The findings showed that a large percentage of patients of DFU (77.23%) were men, aged between 41-60, indicating that there was a high prevalence of DFUs in men in this age group.

The study also explored duration of diabetes in terms of risk of DFU, reporting that a high percentage of participants developed foot complications after having been diabetic for 5-10 years. The results point to chronic hyperglycemia exposure and suboptimal foot preventive care as largely responsible for the formation of DFU. The authors suggested introducing organized foot care educational programs to promote patients' knowledge and self-management. They also highlighted the need for multidisciplinary treatment involving endocrinologists, vascular specialists, and podiatrists to manage DFU more effectively and reduce amputation rates. The findings agree with overseas studies that also highlight the need for earlier detection and treatment in averting foot complications of diabetes

Abrar et al. (2023) investigated how foot care education influences preventing recurrences of diabetic foot ulcers (DFUs) in patients whose wound care is received at Rumah Perawatan ETN CENTER in Indonesia. There was a quasi-experiment on 21 patients who received foot care

education through instructional videos. The findings of the research revealed improvement in patients' awareness on foot care upon receiving foot care education where pre-test scores varied from 3.05 to post-test scores of 10.95 ($p = 0.000$). Appropriate foot care measures of daily foot inspection, proper wearing of shoes, and hygienic maintenance have been found to significantly reduce recurrence of DFU in patients.

The study supports the importance of patient education in diabetes management in that provision of foot care information in an organized way translates to greater self-care activity. The authors advocate for integration of educative videos and culturally sensitive materials in diabetes disease management to increase patient adherence and activity. The findings align with guidelines by the International Working Group on the Diabetic Foot (IWGDF), emphasizing preventive education as a leading strategy in preventing recurrence of DFU as well as associated complications.

2.19 Online Educational Program About Diabetic Foot Ulcer Among Nurses

Online educational programs make learning convenient, affordable, and accessible to nurses. Online courses accommodate space and time limitations to give students an avenue of developing competence on-the-job. A review by Kavitha et al. (2014) concluded that nurses who learned through online courses on wound care considerably boosted their awareness of wound care of DFU prevention, assessments, and possible solutions.

Green-Morris (2019) also evaluated the efficiency of an educational program on foot care conducted in clinic areas in the rural setting, targeting type 2 diabetes patients' increased knowledge and personal care. In Mississippi, one of the states with the highest rate of diabetes, nine patients and four nurses were sampled through convenience. Oral and visual education on foot care regimens, together with both pre- and post-measurements through standardized questionnaires, comprised of the intervention. The results showed an increased level of care of the feet, achieving an average level of satisfaction equaling 4.56 out of 5. The study also, however, noted areas of non-applicability, whereby some of the patients continued practicing risky behavior even after education on preventive care.

The findings support the inclusion of organized foot care education as an integral component of normal care for people with diabetes, particularly in poor rural areas. The study shows that early treatment coupled with continued reinforcement of foot care messages has the capacity to reduce the prevalence of diabetic foot ulcers and leg amputations. Additionally, the study highlights the importance of education programs that are specifically suited to the socioeconomic level and reading ability of the patients. The researcher also calls for further studies, preferably large-scale, to measure the effect of foot care education on both healthcare spending and health over the longer term.

The study indicates the importance of continuous education for healthcare professionals involved in the treatment of diabetes. The study emphasizes that educational insufficiency in the treatment of individuals living with diabetes can lead to poor assessment and early interventions,

elevating the risks of developing ulcers and amputations. They recommend routine foot screening as part of the practice of primary care nurses and national educational sessions so that they are further educated regarding care of the feet. The study aligns with international recommendations aimed at early diagnosis of foot problems so that the rate of diabetes-related amputations lowers.
In Egypt, a quasi-experimental design was conducted by Waheida et al. (2015) to determine the effect of educational programs about foot care on nurses' knowledge, practice, and outcomes for patients with diabetes. In this study, "data were collected from thirty nurses and forty diabetic patients in the medical Department at Tanta University Hospital. Three questionnaires were used for data collection: Questionnaire I: part 1 for Nurse social-demographic and part 2 for Knowledge assessment questionnaire regarding diabetes and foot care. Questionnaire II: part 1 for patients Sociodemographic, part 2 for Knowledge, and part 3 for patient practice assessment questionnaires. Questionnaire III shows Observational checklist for nurses 'practice about Neurovascular assessment for diabetic patients. The result of the study reported that there were significant differences and improvements between studied nurses, pre, immediately, and one-month post-implementation the program. The total practical score of the studied group was good at 93.33% and 90% immediately and after one month respectively. The study found an improvement in patients' foot care practices across all aspects of diabetic foot care following the program." (Waheida et al., 2015)

Khan et al. (2025) carried out a randomized controlled trial study in India. This study aims to evaluate the effect of a blended educational program on nurses' knowledge of diabetic foot care (KAP) among 150 nurses from both urban and rural healthcare settings. A blended learning program, both online and in-person, was implemented over three months. The findings showed that scores of nurses knowledges improved from 55% (baseline) to 90% (3 months). On the other hand, the positive attitudes of nurses increased from 65% (baseline) to 94% (3 months). Additionally, nurses practices improved from 50% (baseline) to 88% (3 months) (Khan et al., 2025).

A quasi-experimental study (pre-test/post-test design) was conducted in the United States in 2017 among 150 registered nurses. This study aims to evaluate the impact of an online education program on nurses' knowledge, attitude, and practice in diabetic foot care by using a 6-week online education program on diabetic foot care. Nurses' knowledge, attitudes, and practice of diabetic foot care was assessed before and after the program using validated questionnaires. The findings showed that the mean levels of nurse knowledge increased from 65% (pre-test) to 89% (post-test). In addition, the positive attitudes of nurses toward diabetic foot care enhanced from 70% (pre-test) to 92% (post-test). Moreover, the nurse's levels of practice significantly improved from 60% (pre-test) to 85% (post-test). The study concluded that nurses' knowledge, attitudes, and practice of diabetic foot care were much enhanced by the online education program, demonstrating the value of digital learning environments (Johnson et al, 2017).

Lilly-West and John (2018) evaluated the effectiveness of interventional training on Rivers State, Nigeria, nursing practitioners' diabetic foot care knowledge. A sample consisting of 100

Rivers State Hospitals Management Board General Hospitals, as well as the University of Port Harcourt Teaching Hospital, nurses, was covered. A one-day workshop, utilizing the National Institute for Health and Care Excellence (NICE) guidelines, was implemented. The results indicated an increased level of nurse knowledge regarding care of the diabetic foot after the intervention. Before the intervention, there was poor knowledge among many nurses, especially regarding footwear assessment, assessment of the ability of the patients to care for themselves, and other areas. Subsequent to the intervention, there was an immense change, whereby the percentage of those possessing good knowledge rose from 60% to 80% ($p = 0.0025$).

The study stresses the importance of systematized educational programs focusing on developing the competence of the nurse in managing diabetic foot. The study advocates continuous professional development, as well as systematized training, to equip the nurse with competences essential for effective management of diabetic foot. The findings also underscore the importance of institutional policies that give emphasis to diabetes education, especially in those areas lacking adequate resources wherein diabetic foot complications are the cause of majority of the lower-limb amputations. The study conforms to other studies indicating that well-educated nurses have an essential role to play in preventing diabetic foot complications by early identification and treatment.

Ramzan et al. (2022) also measure the effectiveness of an educational course to develop the knowledge and practices of nurses toward preventing diabetic foot ulcers in a tertiary care facility in Lahore, Pakistan. A quasi-experimental study utilizing 36 randomly allocated nurses was conducted. The period of the intervention was 16 weeks, including theoretical teaching, practical demonstration, and group discussions. The results indicated an increased level of nurse knowledge, as the median level of knowledge increased from 27 to 52 ($p < 0.001$) post-intervention. Also, there was an observed increased level of nurses' practice regarding neurovascular assessment, as well as diabetic foot examination.

The study emphasizes the importance of preventing diabetic foot complications by educating the patient and early diagnosis. The authors underscore those educational sessions, if well structured, not only enhance one's knowledge but also one's clinical practices, resulting in an improvement in the quality of care. The authors suggest incorporating education on diabetic foot care in nurse education and developing universal protocols for routine foot examination in hospitals. The findings underscore the need for ongoing education to close the knowledge gaps and enhance the quality of care delivered by people living with diabetes.

Ng et al. (2023) explored the impact of foot care, glycemic control, and lifestyle modification through systematic health education by trained nurses on preventing and treating foot ulcers in patients at high risk of diabetes in a general hospital in Macau. There were 90 patients with diabetes that received an intervention or acted as controls in a randomized pattern. Findings showed that foot care knowledge scores significantly improved in the intervention group at follow-up at one month and three months post-education ($p < 0.05$), compared to the control group.

The study highlights the need for specialists in diabetes education as well as prevention of DFU. Proper management of DFU requires that there should be multidisciplinary practice that

includes patient education, regulation of diet, exercise, blood glucose checks, and stress management measures. The findings align with other research in advocating for organized health education as an integral intervention in preventing recurrence of DFUs as well as in promoting patients' own capacity for caring for themselves. Research further recommends inclusion of foot education in diabetes care programs on a routine basis to enhance patients' long-term results

Sheta (2020) conducted a quasi-experimental study to evaluate the impact of an educational program on nurses' knowledge and practice related to negative pressure wound therapy (NPWT) for managing acute and chronic wounds. The study was carried out in the general surgery department of Zagazig University Hospital, Egypt, and included 60 nurses. Results demonstrated improvement in practice and knowledge of nurses after training, with aggregate mean scores for knowledge from 15.85 to 37.10 ($p < 0.001$). Similarly, this entails proportion of satisfactory practice of NPWT from 11.7% before training to 88.3% after training.

The study emphasizes the importance of continuous professional development programs to enhance nursing competency in wound care management. Given the complexity of NPWT and its role in accelerating wound healing, the authors advocate for integrating NPWT training into nursing curricula and hospital policies. The findings align with global recommendations highlighting the need for evidence-based practice in wound management to optimize patient outcomes and reduce healthcare costs associated with chronic wound care.

Additionally, interactive elements such as videos, quizzes, and case studies make online classes engaging, resulting in higher retention and more in-depth understanding. Effective online learning programs typically include the following elements:

- Evidence-Based Content: Modules that align with the latest guidelines for prevention of DFU, leading edge approaches to advanced wound management, and integration of multidisciplinary practice (Aalaa et al., 2022).
- Interactive Learning Tools: Case-based learning, simulations, and self-assessment quizzes to reinforce theoretical knowledge with practical application (Moreira et al., 2021).
- Flexibility and Accessibility: Content designed to accommodate varying schedules and allow nurses to learn at their own pace (Moreira et al., 2021).

Studies have consistently shown that distance-based educational programs have positive impact on practice of care of DFU. More confident practice outcomes have also been reported by nurses that have had prolonged education through internet-based forums on handling complex cases of DFU (Zare et al., 2016). Chiwanga and Njelekela (2015) asserted that online-based programs bridge practice-theory gap by enabling nurses to practice better through evidence-based practice Despite their promise and effectiveness, there are also many barriers and challenges that make effective use of online educational programs problematic. Limited availability of good internet connections, variations of digital competence of individuals, and poor levels of institutions' support are some of these challenges. For making online educational programs most effective, policymakers and health care institutions need to adhere to the following guidelines:

1. Customized Content: Create programs tailored to meet the specific needs of practicing nurses working in diversified healthcare settings.

2. Regular Updates: Update to reflect the latest developments in preventing and treating DFU.
3. Institutional Support: Offer resources like internet provision and digital technology to facilitate participation.
4. Continuous Feedback Mechanisms: Include measures of evaluation and feedback loops to guide program improvement and implementation (Otu et al., 2023).

2.20 Amit Jain's Diabetic Foot "PENTAGON" Anew Model

"Amit Jain's diabetic foot PENTAGON model addresses prevention, education, clinical management and long-term outcomes by encompassing the critical components of care. Its integration into nursing education enhances the knowledge and skills of nurses, ensuring they are equipped to provide high-quality care for diabetic patients. Through structured learning and evidence-based practice, the PENTAGON model has the potential to revolutionize diabetic foot care globally. Amit Jain's diabetic foot "PENTAGON" is one such new teaching model which is an efficient education tool that covers briefly the framework of diabetic foot (Jain, 2021).

"Amit Jain's diabetic foot pentagon is a new concept aimed at understanding the entire framework of diabetic foot in simple manner as it briefly amalgamates almost various concepts of diabetic foot to form a structure" (Jain, 2020b). It is simple, easy to remember model which would be an invaluable tool both for teaching and also to be used in clinical practice to guide them in diabetic foot (Jain, 2020b). Using the PENTAGON model, nursing educators can encourage students to adopt a holistic approach, integrating prevention, treatment, and patient education. This approach fosters critical thinking, enabling nurses to tailor interventions to individual patient needs.

The management of foot complications in diabetes remains an integral part of diabetes management that requires interdisciplinary practice in an organized manner. To handle the challenges of foot complications in diabetes, Amit Jain put forth the Diabetic Foot "PENTAGON" Model—an easy-to-follow model that is all-encompassing in scope to condense all of the leading aspects of foot care in diabetes.

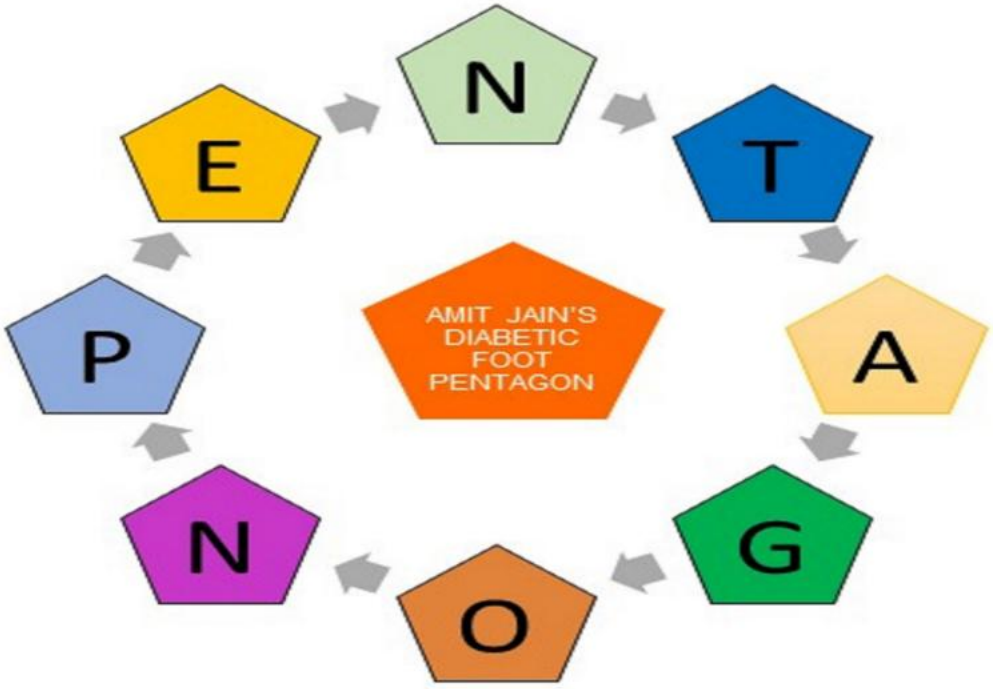
2.20.1 Conceptual Framework Based on Diabetic Foot "PENTAGON": A New Model

Amit Jain's Diabetic Foot "PENTAGON" model offers a comprehensive yet simplified framework for managing diabetic foot complications. The model defines eight interlinking components necessary for proper management by using the term "PENTAGON." The acronym "PENTAGON" is a simple and easy to remember tool and it serves to simplify diabetic foot for health care professionals including family physicians and nurses (Jain, 2021) see Figure 2.20-1.
They include:
P = Pathological lesions

E = Etiology/Evaluation/Education
N = Novel Dressings
T = Therapeutic footwear/ Team approach
A = Amputation/Antibiotics/Adjunct therapy
G = The general status
O = Offloading/Orthotics
N = Never give up.

This review of literature looks at the model in its components individually, its supportive research, and how it would apply in nursing education to improve outcomes in diabetic foot care.

Figure 2.20-2 Amit Jain`s Diabetic Foot Pentagon (Jain, 2021)



2.20.2 Components of the "PENTAGON" Model

1. Pathological Lesions

Diabetic foot presents have several pathological lesions beyond ulcers, including abscesses, cellulitis, Charcot foot, and necrotizing fasciitis. In type 1 diabetes, foot complications often involve infectious lesions such as abscesses, cellulitis, wet gangrene, and necrotizing fasciitis. In

type 2 diabetic foot complications, non-infective complications like trophic ulcers, callus, Charcot foot, dry gangrene, etc are included (Jain, 2021)

In Jordan, a study was conducted to further enhance understanding the source and management of diabetic foot ulcers management of infections in nongovernmental hospitals of Jordan (Abu-Harirah et al., 2021). Furthermore, the "total number of patients for the study was 607; 331 of them wound infected patients, which forms 54.4% of the total population the female number of patients was 124 females (63%) and the male's numbers was 207(37%). The pus culture's patients were 128, which forms 21.1% of the total population, the female number of pus's patients was 40 females (31%) while the male's numbers were 88(69%). The result of the study showed that out of 607 Patients with diabetic foot ulceration (DFU) were 130 out of 148 with diabetic mellitus foot syndrome (DMFS). Diabetic foot ulceration (DFU) therefore contributed 20.3% of DMFS among these subjects. Microbiological culture pattern was total of 17 different pathogenic microorganisms were isolated from the participants, one yeast and 16 types of bacteria, from the diabetic foot swabs for ulcers. S. aureus was the most frequent pathogen followed by E. coli then Acinetobacter spp (MDR) and K. pneumonia, then pseudomonas aeruginosa, then p. mirabilis then Streptococcus agalactiae (group b) then (Enitrobacteria spp and pseudomonas spp and Candida spp and P. vulgaris and K. oxytoca ESBL) then S. viridanse and Enterobacter spp ESBL and Staphylococcus coag. negative). The Enterobacter spp ESBL was the less frequent pathogen.and the study concluded that Diabetic Foot Ulcerations (DFU), is forming about a quarter of the diabetic patient's tissue infections, the causative agents were bacterial and fungal(yeast). Most of the causative pathogens were; Staphylococcus aureus, and Acinetobacter spp (MDR)." (Abu-Harirah et al., 2021)

The risk of development of High resistant drug isolates of diabetic foot ulcers to be multidrug resistance were high by 53% of total isolated pathogens specially with K. pneumonia (K. pneumoniae), Escherichia coli (E. coli) and Proteus mirabilis bacterial (Abu-Harirah et al., 2021).

Aborajooh et al. (2022) performed "a cross-sectional prospective observational study in southern Jordan among patients with DFU, which is aimed at evaluating the clinical characteristics of DFU in southern Jordan and determining the microbiological aspects of DFU infection. A total sample of 64 diabetic patients with DFU was included in this study. The finding showed that most patients included in the study were males with male-to-female ratio of (2.2:1). The mean age was 54 years (SD ± 10.7). The mean duration of DM was 16.4 years (SD ± 7.5) and the mean HbA1c was 9.9% (SD ± 2.1). Neuropathy and anemia were noted in 72% and 44% of patients, respectively. The most frequent bacterial isolates were gram negative bacteria accounts for 29 isolates (45.3%). About 37.5% (24) of bacterial isolates showed MDR pattern. Previous antibiotic use in the last 30 days showed significant association with MDR bacteria (p-value <0.05). Previous history of amputations, presence of neuropathy, renal impairment, retinopathy, presence of anemia, limited joint mobility and presence of foot deformity were significantly associated with Wagner's grade ≥ three. And the study concluded that many factors affect and increase the risk of having high grade diabetic foot ulcer. The most frequent bacterial isolates from diabetic foot ulcers

were gram negative bacteria." High rates of MDR in this study reflect the loose implementation of regulations in Jordan regarding antibiotics dispensing (Aborajooh et al., 2022).

2. Etiology/Evaluation/Education.

Diabetic foot is characterized by a combination of infection, poor blood flow (ischemia), and nerve damage (neuropathy). Affected individuals often experience sensory, motor, and autonomic neuropathy. In feet with reduced sensation, repeated trauma from walking or unnoticed injuries—such as those involving foreign objects—can lead to ulcers or acute infections like abscesses or wet gangrene. Prolonged, poorly managed diabetes may also result in peripheral arterial disease, a condition worsened by smoking. This disease significantly increases the risk of lower limb amputation. Education is known to decrease the incidence of diabetic foot ulceration substantially (Jain, 2021).

A cross sectional study was conducted in Ethiopia by Mekonnen et al. (2021) to assess the risk factors of anatomical foot changes in patients with Type-2 diabetes mellitus. Mekonnen et al. (2021) "collected the data using well-structured questionnaires and diabetic foot assessment checklists. Our results revealed an incidence of diabetics-related foot deformities that varied between 7-12%. These deformities include 7% pes cavus, 8.5% hallux valgus, 9% callus, and 12% Claw/Hammertoe. We also demonstrated diabetic-related chronic complications: 44.9% foot ulcer, 20.4% peripheral neuropathy, and 18.4% peripheral arterial disease. Duration of diabetes ($r= 0.026$, $p\leq0.032$) and drinking alcohol ($r=0.143$, $p\leq0.007$) were significantly and directly associated with diabetic foot deformity. Occupation ($r= -0.157$, $p\leq0.003$), types of diabetes ($r= -0.172$, $p\leq0.002$), and presence of neurological symptoms ($r= -0.120$, $p\leq0.020$) was inversely associated with diabetic foot deformity." Also, only 18.4% of patients were aware of the effects of diabetes on foot health, whereas 15.8% of subjects were identified with appropriate foot care practice mobility among the study population (Mekonnen et al., 2021).

A cross-sectional study was conducted among 1000 diabetic patients in Jordan by Yousef AlAyed et al. (2017). Their study aimed to "examine the prevalence of foot ulcers, foot at risk, and the associated risk factors among Jordanian diabetics. The participants were selected systematically from among every second patient visiting the diabetes clinics at "National Center for Diabetes, Endocrinology, and Genetics" (NCDEG) in Amman, Jordan. The participants were interviewed, examined, and then their medical records were reviewed. The factors including sensory neuropathy, vibratory neuropathy, painful neuropathy, vascular insufficiency, retinopathy, and dermatological changes were recorded for all patients. Foot at risk was identified based on the risk category classification. The results showed that a total of 53 (5.3%) patients had foot ulcers, 17 (1.7%) had undergone amputations, and 172 (17.2%) had feet at risk." In addition, patients with loss of protective sensation, loss of vibratory sensation, and vascular insufficiency of the lower limbs were found to be at a higher risk for the development of foot ulceration (Yousef AlAyed et al., 2017).

Another cross-sectional study was conducted in the same country on 1000 diabetic participants recruited from the "National Center for Diabetes, Endocrinology, and Genetics" in Jordan by Ababneh et al. (2020). To determine the prevalence of, and factors associated with, people with foot deformities, among patients with diabetes in Jordan, the finding revealed that the Prevalence of different foot deformities in Jordan varied between 1.7% - 17.4%. Sociodemographic factors such as age, gender, and shoes choices or presence of diabetes-related microvascular complications (neuropathy and retinopathy) or hypertension were independently associated with foot deformities among the Jordanian diabetic population (Ababneh et al., 2020).

In Jordan, A cross-sectional study was conducted among 144 patients with diabetic foot ulcers who attended the "National Center for Diabetes, Endocrinology, and Genetics" (NCDEG) in Jordan by Alrub et al. (2019). To determine factors associated with the quality of life among Jordanian diabetic patients with foot ulcers. Health-related quality of life was assessed using two self-administered questionnaires: Diabetic Foot Scale-Short Form (DFS-SF) and Short Form-8 (SF-8). The finding reported that Patients with diabetic foot ulcers had low quality of life. Female gender, obesity, presence of PVD, and stressful life events were the most important factors associated with lower quality of life in patients with diabetic foot ulcers (Alrub et al., 2019).

In a review article aimed to detect etiology, pathophysiology, diagnosis and management of diabetics' foot ulcer, Rosyid (2017) showed that "Diabetic foot ulcers (DFU) is a lesion of all layers of skin, necrosis or gangrene that occurs in the soles of the feet in diabetes mellitus (DM) patients, caused by: (1) causative factor (peripheral neuropathy, high foot plantar pressure and trauma); (2) contributive factors (atherosclerosis and diabetes). The treatments of diabetic ulcers consist of determining and repairing the underlying cause of ulcer, good wound care and prevention of ulcer recurrence. The cause of diabetic ulcers can be determined by deep anamnesis and physical examination. DFU therapy includes necrotomy/debridement, reducing the load/pressure on the offensive area, manage the infection by diagnosing the type of bacteria, providing adequate antibiotics and ulcer treatment using wound dressing clean and moist." The review concluded that the incidents of diabetic foot ulcers will increase in the future and require a high cost of care. DFU healing also takes a long time and can lead to amputation in the lower extremities, thus exacerbating quality of life and increasing mortality. Wound healing requires infection control, inflammatory repair, regeneration of connective tissue matrix, angiogenesis/vasculogenesis, wound constriction and reepithelization. Management of DFU management focused on prevention of amputation in lower limb with 3 strategies, namely: identification of risk factor of DFU, acute treatment and prevent complication. Therapy performed on the wound of the DFU is carried out constantly with the type of action that depends on the severity of the ulcer and the presence or absence of ischemia. The basis of DFU therapy is necrotomy/debridement, reducing offloading, managing the infection by diagnosing the type of bacteria and providing an adequate antibiotic, ulcer treatment using wound dressing clean and moist (Rosyid, 2017).

3. Novel Dressings

There are various novel dressings available in market ranging from hydrogel, Foams, alginates, hydrocolloid, etc which can be used in diabetic foot wounds. Usages of these are often based on wounds characteristics. These wound dressings can be divided into active, interactive and passive dressings. These novel wound dressings enhance wound healing by providing moist environment apart from their antimicrobial properties, protection from trauma and by providing comfort. Hydrogels are one of the popular choices of dressing among above (Jain, 2021).

4. Therapeutic footwear/ Team approach

One of the preventive strategies in diabetic foot is use of therapeutic footwear which is essential to protect the feet. Often therapeutic footwear is not used commonly in clinical practice and one can use the Amit Jain's footwear ladder to encourage the usage of footwear. The lowest rung of ladder is barefoot walking and the highest rung is availability of complicated footwears. Amit Jain's triangle of therapeutic footwear is a newly proposed teaching model that provides guidance to available diabetic footwear options. Team approach is also needed when one encounters complex diabetic foot problems. There are studies which show that multidisciplinary team approach can improve outcomes in diabetic foot (Jain, 2021).

A prospective comparative study was conducted in India, "to assess the compliance of healthcare professionals that include physicians, surgeons and orthopedicians in screening of foot in diabetes and analyzing it through Amit Jain's triple assessment. All the new diabetic patients who were admitted in medicine ward by physicians, surgical ward by general surgeons and orthopaedic ward by orthopaedic surgeon were studied by us and they were divided in 3 groups. The results showed that each group had 20 patients. 80% of patients had diabetes of less than 10 years and there was no difference in both groups. Chronic kidney disease was significantly common in patients in group A (P- 0.039*). Foot screening was done by physicians in 15%, 5% by surgeons and screening of foot was not done by orthopedicians. 3.3% of patients were detected to have foot ulcer during screening. The triple assessment of foot consisting of looking for ulcer/infection, feeling foot pulses and testing for sensation was poor on both feet and there was no difference among all 3 groups. Significant association was noted between detection of ulcer and foot screening (P0.003**). The study concluded that –Screening of foot was extremely low among all the 3 specialists. Amit Jain's triple assessment being the simplest and fastest screening tool, can be done with ease requiring minimum instruments." (Jain & Gopal, 2020)

It is not just the patients who need to be educated, but even health care professionals require to be educated on need for screening of foot if reduction in amputation is needed and we believe that this linear foot test should be a minimum evaluation tool for every healthcare professional as it addresses the triad of diabetic foot efficiently and effectively (Jain & Gopal, 2020).

5. Amputation/Antibiotics/Adjunct therapy

Diabetic foot patients may require amputation surgeries or non-amputation surgeries like debridement. Amputations can be minor amputation or major amputations. One can consider the use of Amit Jain's triangle of foot amputations (minor) to choose the best available option for successful foot salvage in case amputation becomes a necessity. Today, debridement is one of the most commonly performed procedures in diabetic foot. Antibiotics are required in infections and must be used judiciously. One should always choose proper antibiotics to decrease the treatment cost, avoid antibiotic resistance and side effects. There are various adjunctive therapies that can help in healing wounds. Negative pressure wound therapy, oxygen therapy, hyperbaric oxygen therapy, etc. are some of the available adjunctive therapies used in different parts of the world (Jain, 2021).

The treatment of diabetic foot ulcers may require surgical debridement of the wound to remove dead tissue which is a host for bacteria; appropriate wound dressings and antibiotics may also be necessary. Relief of pressure on the ulcer is critical to the success of treatment and referral to a podiatrist will be required for continued foot care and assessment for pressure relieving devices.

Jain and Tejasvitaa (2019) carried out "a descriptive retrospective study to study the type of amputations being done in patients with diabetic foot complications. The study participants consisted of 37 patients were included in this study. The results showed that Right foot was most commonly involved foot affecting in 54.1% of the patients. The most common lesion was wet gangrene affecting 37.8%. Minor amputations accounted for 83.8% of the cases with toe amputation being the commonest minor amputation. Almost all the foot amputations done belonged to type 1 foot amputation (Simple). 16.2% of patients required major amputation. The study concluded that Diabetic foot is a leading cause for amputation. Our study showed wet gangrene to be the most common cause for amputation." Toe amputation is the most common type of amputation done in diabetic foot (Jain & Tejasvitaa, 2019).

6. The general status

The general status of the patients may have ischemic heart disease, chronic kidney disease, etc. which are important outcomes of the patients. It around 60% of diabetic foot patients had hypertension, 16.7% had ischemic heart disease and 13.3% had retinopathy and CKD (Jain, 2021). A cross sectional descriptive retrospective analysis of 37 patients show that in order to analyze mortality due to diabetic foot complications, the results found that the majority of patients had type 1 diabetic foot complications (n=29; 78.38%), using Amit Jain's classification. Necrotizing fasciitis was the most common pathological lesion (n=12; 32.43%), followed by abscess (n=7; 18.92%). The most common cause of death was septic shock (n=22; 59.5%), followed by acute myocardial infarction (n=8; 21.6%). The study concluded that the most common cause of death in diabetic foot patients in our study was septic shock (59.5%). The majority of patients (46%) died within a week of admission (Jain & VIswanath, 2017).

A retrospective follow-up study was conducted at Ethiopia to investigate the incidence of DFU and its predictors among newly diagnosed DM patients. A simple random sampling method was used to select 401 study participants. The finding revealed that A total of 387 patients were followed retrospectively for a median follow-up time of 95 months. Out of all, 66 (17.05%) patients developed DFU with an incidence rate of 4 cases per 100 person-years of observation. Diabetic nephropathy (adjusted hazard ratio (AHR) = 2.37, 95% CI: 1.33–54.24), diabetic retinopathy (AHR = 5.56, 95% CI: 2.64–11.74), and increased body mass index (AHR = 1.13, 95% CI: 1.01–1.27) were found to increase the hazard of DFU" (Adem et al., 2020).

7. Offloading/Orthotics

Always offload the foot especially in nonhealing plantar ulcers and Charcot foot. There are numerous offloading available and one can use the Amit Jain's triangle of offloading that provides guidance on available options for offloading ranging from simple offloading like felted foam to complicated offloading like total contact cast. Many patients will also require orthotics and prosthetics and they should be referred at right time for their usage (Jain, 2021)

8. Never give up

Various wounds in diabetic foot are chronic and may require long time to heal. Always have patience towards such patients, passion while treating diabetic foot and perseverance to achieve success (Jain, 2021).

2.20.3 Application of the PENTAGON Model in Nursing Education

2.20.3.1 Structured Curriculum Development

Incorporating the PENTAGON model in curricula for nursing makes for an all-around approach to teaching diabetic foot care. Because of its ease of use, the model is helpful in breaking complicated topics into easy-to-manage pieces of information (Aalaa et al., 2017).

2.20.3.2 Simulation-Based Learning

The PENTAGON model can be used to construct case-based simulations where diabetes foot complications are diagnosed and treated by nursing students. For example, neuropathy presenting in a patient with an initial ulcer makes it easy to apply all of PENTAGON model steps from risk to glycemic control to offloading by the learners (Reardon et al., 2020).

2.20.3.3 Enhanced Critical Thinking

Using the PENTAGON model, teachers of nursing can encourage learners to apply a comprehensive approach that involves prevention, cure, and patient education. Through that approach, critical thinking is developed so that nurses tailor their approach to patients' individualized needs. Amit Jain's PENTAGON model of complications of diabetes foot is a comprehensive but simplified model for managing complications of diabetes foot. By encompassing all of these aspects of care, the model addresses prevention, education, clinical management, and long-term outcomes. Through integration within curricula for nursing, it enhances the proficiency of nurses in practice to deliver outstanding care to patients with diabetes. Through planned practice and learning based on evidence, the PENTAGON model has the potential to have a revolutionary impact on foot care for people with diabetes worldwide (Dailah, 2024).

2.21 Summary of Chapter Two: Litreture Review

In conclusion, diabetic foot ulcers (DFUs) are of critical health significance to individuals living with diabetes, leading to infection, amputation, and loss of quality of life. The causes of DFUs are promoted by poor circulation, peripheral neuropathy, and delay of wound healing, making management and ulcer prevention problematic. The nurses have a critical role to fulfill regarding management and prevention of DFUs, where practice, attitudes, and knowledge of nurses have considerable impacts on care outcomes. Notwithstanding, there are clear discrepancies regarding healthcare practitioners' practice and knowledge of managing DFUs.

To address issues and challenges, online educational programs have evolved as an important method of enhancing nurses' competence and knowledge. Such programs are a flexible, convenient mode of continuing learning that allows health care professionals to stay updated on evidence-based practice on prevention and management of DFU. The effectiveness of distance learning to enhance nursing practice and outcomes is well-documented, making it an important mode of enhancing care of persons at risk of diabetic foot complications.

Furthermore, management of diabetic foot ulcers requires good insight into its pathophysiology, commitment to ongoing educational programs by health practitioners, and integration of evidence-based practice. Online learning is also regarded as a useful and convenient option of offering nurses' appropriate resources to provide exemplary care, hence promoting health and well-being of diabetic individuals accordingly.

3 CHAPTER THREE: METHODOLOGY

3.1 Chapter overview

The purpose of this study was to evaluate the effectiveness of an online educational program towards diabetic foot care on nurses' knowledge, attitude, and practice in Jordan. Quantitative data were used to evaluate the amount of knowledge, attitude, and practice with the intervention. Demographic information was collected from each participant. This chapter provides a discussion of the study design, study setting, sample size, participants based on the eligibility criteria mentioned in this chapter, sampling technique, content validity of the questionnaire, data collection methods, ethical considerations, pilot testing, intervention, how to integrate 8 concepts of Amit Jain pentagon model of diabetic foot into the training program, statistical analysis, and summary.

3.2 Research Design

A quasi-experimental, one-group pre-test/post-test design was utilized. Quasi-experiments are similar to randomized controlled trials in many respects, but there are many challenges in designing and conducting a quasi-experiment when internal validity threats are introduced from the absence of randomization (Maciejewski, 2020). A quasi-experimental design also involves the manipulation of the independent variable but lacks either randomization or a control group. In quasi-experimental designs, researchers are observers noting the occurrence of the variables of interest and trying to determine relationships and differences (Schmidt & Brown, 2019). The nonintervention group is referred to as a comparison group rather than a control group (Schmidt & Brown, 2019). Researchers are able to measure the group on the dependent variable prior to and after the intervention (Schmidt & Brown, 2019). The most common quasi-experiment is a non-equivalent comparator cohort wherein patients self-select into (or a provider selects on behalf of a patient) either treatment or usual care and are then followed for a defined period (Maciejewski, 2020). The internal validity of this basic quasi-experimental design can be enhanced by other design, measurement, and analytic methods that are outlined further below. In brief, the internal validity of a quasi-experiment can be greatly improved by including a matched comparator cohort with multiple pre-period assessments of the outcome and one or more non-equivalent outcomes that are not expected to change in response to the treatment of interest (Maciejewski, 2020). It should also be noted that prospective quasi-experiments are also valid and may provide the researcher the ability to collect data on outcomes and confounders that would not otherwise be available in a quasi-experiment that relies exclusively on data from administrative claims (Maciejewski, 2020). The challenge in identifying the target patient population for a quasi-experiment is deciding how broadly or narrowly to define the population and the extent to which data exist to construct and apply the inclusion/exclusion criteria of a trial or real-world clinical practice.

These challenges have implications for the internal and external validity of the study (Maciejewski, 2020). This research design is most appropriate for studies that seek to compare key variables of an accessible population while at the same time allowing for examination of current situations within existing environmental contexts.

The study was designed to evaluate the effectiveness of an online educational program about diabetic foot care on nurses' knowledge, attitude, and practice in Jordan. The participants completed online questionnaires at two time points: (a) T0: before the intervention and (b) T1: after the intervention to determine the retention of results. The study was implemented between January 2024 and March 2024. The study was conducted to determine the effectiveness of the online educational program on levels of knowledge, attitude, and practice among nurses towards diabetic foot care in Jordan.

3.3 Study Setting

This study was carried out in selected eleven government hospitals of the Ministry of Health (MOH) located in the southern, middle, and northern regions of Jordan. These hospitals are the major hospitals serving the population of Jordan. According to MOH (2024), the Jordanian healthcare system is divided into government, military, teaching, and private institutions. The MOH operates 33 hospitals that employ 7540 registered nurses (RNs) and 2228 licensed practical nurses (LPNs). Two teaching hospitals have 1,433 RNs and 204 LPNs. The military operates 16 hospitals that have 4,593 RNs and 2,998 LPNs. Sixty-nine privately operated hospitals have 10,364 RNs (MOH, 2024).

The eligibility criteria for the MOH hospital were the selection of the hospitals that have (a) ICUs, (b) general surgical wards, (c) general medical wards, (d) diabetic\diabetic foot clinics, (e) emergency, and (f) outpatient clinics.

The author selected the governmental hospital according to these criteria: (a) the government has a large sample of nurses, (b) easy to obtain approval from the research and ethics committee of the MOH, (c) the governmental hospital has a same policy for any procedure, (d) while military and private have a different policy to apply any nursing procedure, (e) governmental hospitals form a large healthcare system in Jordan, and (f) nurses in governmental hospital have the same diabetic foot ulcer treating and prevention courses.

3.4 Sample Size

Sample size estimation for a research study is the most crucial part of the research process because it helps to produce reliable results, which improve the generalizability of study results. A researcher must have an understanding of significance level, effect size, and study power in the event among participation and design effect to use sample size

calculation efficiently. A sample that is too large is merely a waste of resources and time. Alternatively, a sample size that is too small fails to produce conclusive and reliable results. Therefore, sample size estimation is also essential to know the feasibility of the study in terms of required cost and time. The sample size was determined based on G*Power 3.1 (Faul et al., 2017). Parameters for effect sizes (medium = 0.5) were used. Effect size is an estimate of how large a difference was observed between the groups. In addition, a minimal alpha significance level of .05 was chosen. The significance level is the alpha level established before the beginning of the study (Schmidt & Brown, 2019). The power analysis of this study was .95. Power analysis is a statistical method to determine the acceptable sample size that will best detect the independent variable (Schmidt & Brown, 2019). Another factor that researchers need to consider when conducting quantitative studies is attrition rate, also known as dropout rate. Typically, some subjects agree to participate in a study and, for whatever reason, do not complete the study. Attrition is a threat to internal validity, and the researcher should attempt to create a study design that minimizes the loss of subjects. One method to address attrition is to increase the number of subjects in the sample so that even with losing subjects, the researcher will have a sufficient sample size for the research study (Schmidt & Brown, 2019).

Target sample size and drop were considered based on previous literature, although data were obtained using the same type of study design was limited. When the medium effect size of .5 was considered, the number of participants was 45. The attrition rate (10-15%) of the sample was added to the sample size, and a total of 130 questionnaires were distributed to the nurses. Out of 130, approximately 115 nurses responded to the questionnaires, which is a response rate of 90%.

3.5 Sampling Procedure

A convenience sample was used to collect data from participants. Convenience samples are considered a type of non-probability sampling method based on the selection of the most readily available persons as participants in a study, also called accidental sampling (Polit & Beck, 2004). In convenience sampling, also known as accidental sampling, researchers select elements for inclusion in the sample because they are easy to access (Schmidt & Brown, 2019). To obtain participants for this study, convenience sampling was used because of the limited number of eligible nurses (Polit & Beck, 2004). Convenience sampling is a method for choosing subjects who are suitable, available, or approachable. The accessible population of the study involved all 1,946 nurses working in the selected hospitals.

3.6 Participants

This study targeted nurses working at a governmental hospital in MOH in Jordan. The target participants were selected RNs and LPNs who work in the selected hospitals and diabetic clinics in Jordan. The term LPN (assistant nurse) is used in accordance with the MOH. In Jordan, the qualifications and experience of nurses were as follows: RN and LPN. Both RN and LPN are nursing professions that provide medical treatment and assist in examination. The major differences between RN and LPN are in terms of the place that issues the qualifications and the qualification requirements. The license for a registered nurse is given by the Jordanian Nursing Council (JNC), whereas that for an LPN is given by the MOH, according to the following eligibility criteria.

3.6.1 Inclusion Criteria

Nurses needed to have clinical experience for not less than three months. The justification for this inclusion was nurses who had worked a sufficient time in the diabetic clinics or other units in the hospitals. Hence, they had enough clinical experience to share with the researcher. In addition, nurses who were working in the following units: outpatient clinics (wound care rooms\diabetic foot clinic), general surgical wards, general medical wards, diabetic foot clinics, emergency room (ER) and intensive care unit (ICU). The justification for this inclusion was to ensure the study setting. The nurses described their knowledge, attitudes, practice, and years of experience and provided a deep insight into the studied phenomena.

3.6.2 Exclusion Criteria

Exclusion criteria in this study were nursing students, administrative nurses who did not work with patients, nurses who could not be reached for various reasons (e.g., annual leave, vacation, maternity leave), and nurses who were not willing to participate in the study.
At the end of the training process, those nurses who did not complete the course sufficiently due to lack of attendance or commitment to training were excluded from the study.

3.7 The Questionnaires

Questionnaires are commonly used in quantitative research and can provide an inexpensive way to gather numerical data from a potentially large number of respondents. Questionnaires are typically inexpensive to administer when compared to other data

collection methods. Each question needed to be monitored for clarity, sensitivity to the respondent, reading level, and absence of bias. Questionnaires can be administered in person pre-education programme while after education programme Questionnaires can be administered on computers and handheld devices, via google drive link sent through email. E-questionnaires are growing in popularity and may be used as a strategy to enhance response rates (Schmidt & Brown, 2019). Validated questionnaires were used to assess the knowledge, attitudes, and practice of nurses towards diabetic foot care (Al-Meʿani & Al-Wahsh, 2020; Bilal et al., 2018; Sukri et al., 2020). As nursing education is conducted in the English language in this country, the English version of the questionnaire was distributed without the need for translation (see Appendix B).

The reliability of the instrument was assessed by the authors of the instruments. The Cronbach's alpha values of (.704) for the knowledge section, (.728) for the attitude section, and (0.897) for the practice section were considered acceptable. The questionnaire comprised four sections. The first section, developed by the author from previous literature, consisted of questions regarding the demography of the survey participants, such as region, gender, age, work experience in a year, level of nurse qualification, current working hospital, current working unit, current level of wound care knowledge, involvement in diabetic foot ulcer (DFU) care, and formal training on diabetic foot care.

The second section refers to assessing the knowledge of nurses on diabetic foot care. This section comprised 14 multiple-choice questions (MCQs) on the most pertinent areas of diabetic ulcers: (a) knowledge regarding predisposing factors and characteristics for DFU, (b) knowledge regarding foot assessment, (c) knowledge regarding prevention and complications of foot ulcer, (d) knowledge regarding DFU care. MCQs had three answer options, "True," "False," and "Do not know." The third option was included to minimize guessing and to prevent leaving questions unanswered. When scoring, correct answers scored one point each, while incorrect answers and "Do not know" options scored zero. As a result, the lowest and highest total scores possible were 0 and 14, respectively.

Based on the median score, the level of knowledge was divided into two levels (Sharmisthas et al., 2014). A knowledge score ≥ median was considered "adequate knowledge" and a knowledge score < median was considered "inadequate knowledge." The author selected the median score to classify nurses' knowledge into two groups regarding the following causes: (a) median is a value that divides the data into two equal parts, (b) insensitive and not affected by extreme value, (c) and simplicity (Polit & Beck, 2004).

The third section assessed the nurses' attitudes towards diabetic foot care. This section was comprised of eight questions on the most pertinent areas of diabetic ulcers: (a) attitudes regarding to clinical priority of caring for DFUs, (b) attitudes regarding nurses' interest towards diabetic foot care, and (c) attitudes regarding caring for DFUs. To answer questions, MCQs had a five-point Likert ranging from one to five, in which one meant "Strongly Disagree" and five meant "Strongly Agree" (i.e., "Strongly Disagree," "Disagree," "I don't know," "Agree," "Strongly Agree"). As a result, the lowest and highest total possible scores

were 8 and 40, respectively. Levels of attitudes were classified into two groups. Attitude score ≤ median score of attitudes were considered "non-favorable attitude." Attitude score > median score of attitudes were considered "favorable attitude" (Sharmisthas et al., 2014).

The fourth section assessed the nurses' practice of diabetic foot care. This section comprised 12 questions on the most pertinent areas of diabetic ulcers: (a) Practice regarding foot assessment, (b) practice regarding patient education towards diabetic foot care, (c) practice regarding footwear, and (d) practice regarding dressing and treatment of DFU care. To answer questions, MCQs had a five-point Likert ranging from one to five in which one meant "Never" and five meant "Always" (i.e., "Never," "Rarely," "Sometimes," "Often," and "Always"). As a result, the lowest and highest total possible scores were 12 and 60, respectively. Nurses who scored equal to or greater than the median score for practice were presumed to have sufficient practice in diabetic foot care. In contrast, insufficient practice was classified as a score lesser than the median value for practice. Levels of practice were classified into two groups. A practice score ≥ median score of practice was considered "sufficient practice." A practice score < median score of practice was considered "insufficient practice" (Al-Meʿani & Al-Wahsh, 2020) (see Appendix B).

3.8 Content Validity

Since this was the first time that the questionnaire was utilized in a Jordanian sample, the suitability of the questionnaire for the intended population had to be ascertained (i.e., its validity and reliability).

Content validity is concerned with how well the question items correspond to the concept (Saw & Ng, 2001). In addition, it is concerned with the adequacy of coverage of the content area being measured (Polit & Beck, 2004). The content validity of the instrument can be determined using the viewpoints of the panel of experts (Zamanzadeh et al., 2015). The researcher used a panel of experts from Jordan to assess content validity. The panel of experts consisted of five people: one who had experience as a consultant general surgeon, two who had an assistant professor in nursing, and two nurses who worked in diabetes foot clinics. There are multiple methods for testing content validity. The Content Validity Index (CVI) is the most commonly used method to calculate content validity quantitatively (Rodrigues et al., 2017). CVI included a rating Likert of four choices for each item in the questionnaire as follows: 1 = non-relevant, 2 = somewhat relevant, 3 = relevant but requiring a minor change, and 4 = relevant. To obtain CVI for the relevancy and clarity of each item (I-CVIs), the number of those judging the item as relevant or clear (rating 3 or 4) was divided by the number of content experts, but for relevancy. CVI can be calculated both for item level (I-CVIs. The I-CVI expresses the proportion of agreement on the relevancy of each item, which is between zero and one. (Zamanzadeh et al., 2015). After the content validation process, the experts gave between three and four for all items, where the total CVI for the tool was 0.75.

The following modifications were made based on the recommendations of the panel members: section (A): socio-demographic data: deleted item about "graduate institution" and section (B): assessment of knowledge: added (item number 1) "I think diabetic ulcer treatment is more important than ulcer prevention." Also, added (item number 2), "I do not think it is necessary to assess diabetic wounds regularly." In addition, in item number 4, "sensory neuropathy may result from ulcers forming," replaced "sensory neuropathy results in unnoticed skin damages which leads to the formation of ulcers." Moreover, in item number 13, "change to offloading treatment should facilitate ulcer healing" replaced "mechanical offloading should be advised to facilitate ulcer healing." In the knowledge section (item number 16) "dressings are effective in healing wounds with clinical signs of infection" replaced "iodine dressings are effective for wounds with clinical signs of infection." In section (C): assessment of attitude transfer (item number 1) "I think diabetic ulcer treatment is more important than ulcer prevention" to section (B) assessment of knowledge. Also, in item number 2, "I do not think it is necessary to assess diabetic wounds regularly" transfer to the knowledge section. In section (D): assessment of practice: in item number 12, "Using the appropriate offloading devices" replaced "I redistribute pressure applied to foot ulcer(s) by the appropriate offloading devices." Based on recommendations provided by panel members, adjustments were made to the questionnaires (see Appendix B).

3.9 Pilot Study

3.9.1 Introduction

prior -test of the instrument Questionnaire was used to ensure its acceptability and appropriateness for the target population and the community being studied. The face validity of the questionnaire was tested with a pilot group representing 10% of the study sample (n = 10). The nurses who participated in the pilot study were recruited from outside the overall study population, but with the same inclusion and exclusion criteria to ensure consistency. Pilot studies are an essential part of the research process that focuses on testing the feasibility, clarity, and reliability of measurement tools and protocols. They are useful for identifying potential barriers, allowing modifications to be made, and thus helping to increase the validity and reliability of the study. (Thomsen et al., 2024).

3.9.2 Purpose of the Pilot Study

The first objectives of this pilot study were to assess the clarity of the questionnaire items, assess the reliability of the electronic tool, and assess the timeline and logistics of the online application as well as participant engagement in the online training. The findings of

this preliminary stage were also used to perform a series of adjustments to maximize the main study (Jiménez-Rodríguez et al., 2021).

3.9.3 Clarity of the Questionnaire Items

According to the feedback from the participants, the items of the questionnaire were understandable, and no responses indicated difficulty with the phrasing. However, the 10 minutes I had dedicated to it was not enough. Therefore, in the main study, the duration was increased to 20 minutes to guarantee participants enough time to provide thoughtful responses (Jiménez-Rodríguez et al., 2021).

3.9.4 Validity and reliability of the instrument:

The internal consistency of the questionnaire was evaluated using Cronbach's alpha, with the following results.

3.9.4.1 All Questions (Overall Assessment)

The Cronbach's alpha for the full assessment was .90. This suggests a very high consistency among the 20 items, indicating they collectively measure a common underlying concept, which aligned with the standards set by Polit and Beck (2004).

3.9.4.2 Attitudes Toward Prevention and Management of Diabetes Foot

This section, focusing on attitudes towards foot prevention and care, had a Cronbach's alpha of .858. While slightly below the ideal .9, this value still reflects a solid internal consistency among its eight items, showing that these questions effectively capture the same general attitude.

3.9.4.3 Nurses' Practice of Diabetic Foot Care

The results for the nursing practice section showed a Cronbach's alpha coefficient of 0.881, demonstrating excellent internal reliability and validity across the twelve items. This indicates that these questions consistently measure the intended construct. Overall, the Cronbach's alpha values for the different sections of the questionnaire demonstrated strong internal consistency, confirming the validity of the instrument as a reliable tool for assessing nurses' attitudes and practices regarding diabetic foot care (Jimenez-Rodriguez et al., 2021).

Nurses' participation in the online sessions:

Four training sessions were initially planned. However, to ensure comprehensive coverage of the topic, two additional sessions were added during the main study, bringing the total to six. This expansion allowed for a more comprehensive integration of theoretical knowledge and practical skills in diabetic foot care (Haines et al., 2022).

3.9.5 Timeline and logistical planning for online delivery:

The first two sessions were held during weekdays. Based on feedback from participants, I modified the session schedule so that subsequent sessions were held on Fridays and Saturdays, which are the days off for most nurses. The training extended over three consecutive weeks, with two sessions per week. All sessions were conducted via Google Meet and were easily accessible by emailing participants with a link to the session (Sawyer et al., 2022).

3.9.6 Sample size and procedures:

Ten nurses participated in the pilot study who met the inclusion criteria for the pilot study, equivalent to approximately 10% of the target sample size, and participants in the pilot study were excluded from the main study. Initially, an introductory face-to-face interview was conducted, during which participants were informed of the study objectives and procedures, their right to withdraw at any time without giving reasons, and informed consent was obtained from all participants wishing to join the training program. About a week later, an email was sent with the schedule and link to the first session, which was conducted via Google Meet. After the six sessions, the follow-up questionnaire was distributed electronically via email using Google Forms (Jiménez-Rodríguez et al., 2021).

3.9.7 Duration between pre- and post-test assessments

The time between completing the pre- and post-questionnaires was approximately six weeks, allowing participants enough time to engage with the educational material and implement their new knowledge effectively (Hines et al., 2022).

3.9.8 Preliminary observations and resulting modifications

The questions were clear, but the time taken to complete them was slightly increased to

improve data quality. The session lengths ranged from one to two hours. To ensure thorough coverage, the total number of sessions was increased to six. All participants completed the questionnaires within the scheduled timelines. Feedback led to adjustments in the session schedule to better match participants' availability, which improved attendance and engagement. These changes, based on insights from the pilot, played an important role in refining the design and execution of the main study (Sawyer et al., 2022).

3.10 Ethical Considerations

The procedure for data collection was as follows: Permission to carry out the study was obtained from the faculty of nursing of the University of Valencia, the Research and Ethics Committee of the MOH in Jordan (Ref. MOH/REC/2022/110) (see Appendix C), and subsequently arranged with the nursing directors of the selected hospitals to explain the study's purpose and data collection process.

After obtaining permission from MOH in Jordan, nurses were selected according to the inclusion and exclusion criteria and agreed to participate in the study. Next, signed consent forms from nurses to participate in the study were obtained by the author from all participants from all units (see Appendix A).

In adherence to ethical standards, the author informed the participants that all personal information that was gathered in this study was kept confidential, no individual's performance could be identified, and the statement regarding the participants' ability to withdraw from the study at any time without penalty.

Alternatively, the author was given permission to use the tool in the current study from the original author (see Appendix D). Also, the author got permission from the International Working Group on Diabetic Foot Guidelines (IWGDG) in an online educational program about DFU (see Appendix E). In addition, the author took permission from Dr. Amit Jain to use the diabetic foot "PENTAGON" model in the current study (see Appendix F).

All of the data were treated, analyzed, and presented as group data. All information remained confidential throughout the study, and the responses of individual nurses were not identified. An assigned numeric coding system was used to match each hospital and information. For security purposes, data collected on selected nurses were analyzed using the Statistical Package for Social Sciences (SPSS) version 24. The data were stored on the personal laptop of the author, and the second copy of the data was saved in Google Drive if the data were lost from the laptop. Only the author had access to this laptop.

3.11 Data Collection Procedure

Every participant who agreed to participate was given a packet containing the demographic data form and the Knowledge, Attitudes, and Practices (KAP) questionnaire

(Appendix B) pre-educational program. The introductory page explained that the questionnaire was voluntary and would take about 20 minutes to complete; each participant was instructed not to indicate their name or affiliation. The author distributed the questionnaire to participants, and when the participants completed the questionnaire, each one sent it to the researcher. All the data were collected by the same researcher. Post-online educational program, the researcher was sent the same questionnaire via email to be completed among nurses. The recruitment process of the sample began in February 2024 and continued through March 2024.

Although the training program was conducted remotely (online), the pre-training questionnaire was collected in person, while the post-training questionnaire was distributed and collected via email after the program's conclusion. This mixed-mode approach was adopted because of several organizational and practical considerations, as detailed below.

3.11.1 Pre-Training Questionnaire Collection

To ensure the seriousness and reliability of the collected data, the pre-training questionnaire was administered in person. This approach allowed the researcher to:

- Confirm participants' commitment to the training and their readiness to engage actively.
- Verify participants' identities and ensure the accuracy of the submitted data.
- Provide clear instructions and emphasize the importance of the questionnaire, thereby enhancing response quality.

3.11.2 Post-Training Questionnaire Collection via Email

Following the completion of the training, the post-training questionnaire was distributed and collected electronically through email. This method was chosen to:

- Facilitate participant response without the need for physical attendance.
- Align with the online nature of the training program.
- Accelerate data collection and enable prompt analysis using digital tools.

3.11.3 Intervention (Educational Programme)

The online training program sequence was a pre-test KAP survey. The author distributed the pre-test questionnaire to the participants face-to-face in the hospital. All nurses assessed the levels of knowledge, attitudes, and practice towards diabetic care foot among Jordanian nurses. The nurses participated in this study according to the inclusion criteria mentioned previously. The intervention was conducted through an online educational program on diabetic foot care that consisted of a virtual lecture on the Google Meet platform. The author was sent the link to the meeting on the group via email. The intervention was created based

on Amit Jain's PENTAGON diabetic foot model and the IWGDG.

The researcher prepared the teaching aids and media (e.g., Google Meet platform, videos), and at the end of the session, a post-test KAP survey to evaluate the effectiveness of the educational program was carried out immediately after program implementation using the same questionnaire.

The intervention was conducted in three phases:

Phase I: Data Collection and Assessment

Pre-Test KAP Survey

Prior to the start of the program, the researcher distributed the KAP questionnaire face-to-face to all nurses meeting the inclusion criteria at their workplace. Two validated instruments were used:

- The Questionnaire on Assessment of Nurses' Knowledge and Attitudes on DFUs (Kumarasinghe et al., 2018).
- The Practice of DFU Questionnaire (Al-Meʿani & Al-Wahsh, 2020).

Phase II: Educational Program Implementation

The goal of the educational training program was to provide staff training on knowledge, attitudes and practice regarding diabetic foot care will be implemented through four sessions according to Amit Jain's diabetic foot PENTAGON model for teaching and training healthcare professionals such as nurses about a diabetic foot. Amit Jain's (2021) diabetic foot PENTAGON is a new concept that is an efficient education tool that briefly covers the framework of diabetic foot. The educational session was given to all nurses in the study in one group each. The educational session was given for two hours using lecture, discussion, and handout, which was given to all nurses included in the study. The handout related to diabetic foot care was written in the English language to be easily understood by all nurses, and it included all knowledge, attitudes, and practices needed regarding diabetic foot care. The program components were derived from Amit Jain's diabetic foot PENTAGON model, which consists of eight domains as follows: (a) pathological lesions of DFU, (b) etiology\evaluation\education of DFU, (c) novel dressing, (d) therapeutic footwear\team approach, (e) amputation\antibiotic, (f) the general status, (g)

offloading/orthotics, and (h) never give up. The researcher prepared the teaching aids and media (e.g., Google Meet link, picture, video).

3.11.4 Integrating the PENTAGON Model into the Training Program

This training program has been meticulously designed around Amit Jain's PENTAGON model for diabetic foot care, a comprehensive and clinically validated framework that guides the multidisciplinary management of DFUs. The model consists of eight core domains, each representing a vital aspect of effective diabetic foot care: pathological lesions, etiology, evaluation, patient education, advanced dressing techniques, therapeutic footwear and multidisciplinary collaboration, antibiotic and amputation strategies, general health assessment, offloading and orthotics, along with the psychosocial principle of "Never give up."

Each session within the program was intentionally aligned with one or more of these domains, ensuring a coherent integration between theoretical content and clinical application. This alignment fosters a structured and progressive learning experience that supports a comprehensive understanding of diabetic foot management in line with current best practices. The mapping of the sessions to the PENTAGON domains was as follows:

- Pathological lesions:
    - Covered in session 2, which focuses on the phases of wound healing, and session 4, which addresses the assessment and grading of DFUs.
- Etiology, evaluation, and education:
    - Addressed in the introductory session, session 3 (holistic Assessment of the Diabetic Foot ulcer), and session 4 (assessment and grading of the DFU).
- Novel dressing techniques:
    - Presented in session 6, which is dedicated to dressing selection algorithms.
- Therapeutic footwear and multidisciplinary approach:
    - Integrated into session 3 and session 5, where comprehensive assessment and core management principles are discussed.
- Antibiotic use and amputation strategies:
    - Explored in session 3 and session 5 within the context of holistic management and DFU care essentials.
- General health status:
    - Covered in session 3, which focuses on the overall clinical evaluation of the patient.
- Offloading and orthotics:
    - Emphasized across various sessions involving assessment and treatment planning, particularly in sessions 3 and 5.
- "Never give up" principle:

- Embedded throughout all sessions as a unifying theme to promote patient empowerment, motivation, and continuity of care.

This structured incorporation of the PENTAGON model ensured that the training was not only evidence-based but also aligned with international clinical standards. It offered nurses a comprehensive and multidimensional educational experience that enhanced their competence in assessing, preventing, and managing diabetic foot complications within real-world healthcare environments.

Session 1: Introduction to Diabetic Foot Care

The specific objective was that by the end of the session, nurses would be able to define DFU, identify its main etiologies (including peripheral and motor neuropathy, Charcot foot, and peripheral artery disease), and differentiate among neuropathic, ischemic, and neuro-ischemic symptoms, achieving 100% accuracy based on responses to the online module's interactive slides and knowledge checks.

- Content matter: (ADA, 2021).
  - Definition of DFU.
  - Statistics of the problem.
  - Etiology of the DFU.
  - Peripheral neuropathy.
  - Motor neuropathy.
  - Charcot foot.
  - Peripheral artery disease (PAD).
  - Typical symptoms for neuropathic, ischemic, and neuro-ischemic.
- Time frame: Three hours.
- Teaching strategy: PowerPoint presentation including (clinical images), interactive lecture with guided discussion, post-session review.
- Equipment: Google Meet program, Whats App application, slides.

Session 2: The Wound Healing Process

The specific objective was that by the end of the session, nurses would be able to define the concept of hemostasis and its significance in immediate bleeding control, explain the three key phases of wound healing (i.e., inflammation, proliferation, and maturation), and identify clinical and physiological factors leading to delayed healing in DFUs, based on IWGDG (2024) guidelines, with at least 90% accuracy in alignment with the online assessment criteria.

- Content matter: (IWGDG, 2024).
  - Hemostasis stops bleeding immediately.
  - Three phases of wound healing.
  - Interrupted and delayed wound healing at DFU.

- Time frame: Three hours.
- Teaching strategy: Interactive lecture, group discussion.
- Equipment: Google Meet program, WhatsApp application, slides including (clinical images).

Session3: Holistic Assessment of the Diabetic Foot Ulcer

The specific objective was that by the end of this online session, nurses would be able to accurately perform and interpret a comprehensive diabetic foot assessment—encompassing general patient evaluation, foot inspection, neurological testing, and vascular screening—based on the IWGDG (2024) guidelines.

- Content matter: (Jain, 2021).
    - The multidisciplinary foot care team (MDFT).
    - General assessment of the patient (i.e., physical and mental health, diabetes control, blood pressure and cholesterol status, smoking, nutritional status, and previous history of foot ulcer).
    - Inspecting the feet (i.e., skin, nails, lack of hair, any previous amputation, ulcer, gangrene, temperature, deformities of the foot, and Charcot foot).
    - Testing loss of sensation (i.e., sensation test with 10 g monofilament, perception of vibration with tuning fork 128 HZ, and test the ability to feel vibration with biothesiometer).
    - Testing of PAD: ankle-brachial pressure index (ABPI), toe-brachial index pressure (TBI).
- Time frame: Three hours.
- Teaching strategy:
    - Interactive lecture using slides and verbal explanations.
    - Guided video-based learning: (a) sensation test with monofilament, (b) test perception of vibration with a tuning fork, (c) test the ability to feel the vibration with biothesiometer, (d) ABP, and (e) TBI.
    - Equipment: Google Meet program, WhatsApp application, PowerPoint presentation (shared screen).

Session 4: Assessment of the Ulcer and Grading the DFU

The specific objective was by the end of this online session, nurses would be able to identify and interpret the key clinical features of DFUs—including size, location, depth, infection signs, and classification based on ADA (2021) guidelines.

- Content matter: (NICE, 2019).
    - Examination of the DFU.
        a. Location, size, and depth.
        b. Appearance of wound bed.

c. Wound edges and surrounding skin.
d. Exudate level.
e. Pain.
f. Mal odor.
g. Diabetic foot infection.
h. Diabetic foot infection classification.
i. Diabetic foot infection (assessment of biofilm).
j. DFU grading system.

- Time frame: Three hours.
- Teaching strategy:
  - Interactive lecture using slides and verbal explanations.
  - Demonstration videos showing ulcer types and grading examples.
  - Open question and answer sessions to clarify concepts.
- Equipment:
  - PowerPoint presentation (shared screen).
  - ADA 2021 guideline summary (digital handout).
  - Educational videos on DFU grading.

Session 5: Essential Component of DFU Management

The specific objective was by the end of this online session, nurses would be able to identify and select appropriate wound care techniques for diabetic foot ulcers based on the eight essential components of DFU management—such as pressure offloading, infection control, exudate management, and appropriate dressing selection.

- Content matter: (NICE, 2019).
  - Eight essential components of DFU management
    a. Treating the underlying disease.
    b. Oxygen therapy.
    c. Pressure offloading.
    d. Infection\inflammation control.
    e. Debridement.
    f. Exudate management.
    g. Pain management.
    h. Edema management.
- Time frame: Three hours.
- Teaching strategy:
  - Interactive lecture: presentation covering the eight core components of DFU management.
  - Case-based scenarios: Virtual patient cases presented through slides or videos.
  - Video demonstrations: Visual guides showing techniques such as dressing selection, pressure offloading, and infection control.

- Equipment:
    - Digital slide presentation (PowerPoint).
    - Instructional videos demonstrating each of the eight DFU care components.
    - Case studies in PDF or interactive formats.
    - ADA and IWGDG guideline summaries (downloadable).
    - Access to webinar software (e.g., Google Meet).

Session 6: Diabetic Foot Ulcer Dressing Algorithm

The specific objective was that by the end of this online session, nurses would be able to describe the principles of DFU dressing selection and apply evidence-based decision-making to choose the appropriate type of dressing based on wound characteristics—such as exudate level, infection status, and tissue condition—using standardized DFU dressing algorithms. Content matter:

- Dressing for DFU care.
- Dressing selection guide.

- Time frame: Three hours.
- Teaching strategy:
    - Interactive lecture:
        a. Explanation of dressing principles and selection criteria using annotated slides and clinical image.
    - Video demonstrations:
        b. Embedded videos showing how different dressings are applied based on wound type and condition.
    - Discussion forum:
        c. Peer exchange on dressing decisions and clinical reasoning behind product selection.
- Equipment:
    - PowerPoint slides with dressing selection algorithms.
    - Instructional videos demonstrating the application of various DFU dressings.
    - Clinical images of DFU with different wound bed conditions.
    - Dressing selection guide (PDF) based on IWGDG or national protocols.
    - Access to online platforms (Google Meet) for interaction and submission.
    -

Phase III: Evaluation

Immediately after the sixth session, the same KAP questionnaires were emailed to all participants to measure changes in knowledge, attitudes, and practices. For data analysis, pre- and post-intervention scores were compared statistically to determine the program's effectiveness in improving diabetic foot care competencies among nurses (Al-Meʿani & Al-Wahsh, 2020; Kumarasinghe et al., 2018).

3.12 Data Analysis

For data analysis and organization, the SPSS software version 24.0 was used. Once the data were entered into the software, they were cleared and filtered for any outliers or missing data. Items that were not answered or answered completely were excluded from the data analysis.

The collected data were tabulated and analyzed, and descriptive statistics were conducted for categorical variables to calculate the median, percentage, and frequencies. Continuous variables were expressed as mean and standard deviation (SD). The level of significance was considered alpha ($p = 0.05$). Furthermore, descriptive statistical analysis with median values was presented and used to determine the levels of knowledge, attitude, and practice of Jordanian nurses on the care of diabetic foot conditions both before and after their participation in an online educational program. In the median test, scores for both groups were combined, and an overall median was calculated, the next tables (Table (4.2), (4.5), (4.8)) resume the statistical median test.

A paired-sample t-test was also utilized to investigate further, analyzing the levels of knowledge, attitude, and practice scores among nurses prior to and after an online educational program on DFU. This test of analysis was chosen because it is appropriate for comparing the means of two related groups. A paired t-test is one of the parametric approaches for detecting differences between group means, the next tables (Table (4-4), (4-7), (4-10)) resume the statistical paired t test.

In addition, to explore the associations among knowledge, attitudes, and practice levels of nurses and their demographic characteristics regarding pre- and post-online educational program participation, a combination of descriptive statistics and analysis of variance (ANOVA) was employed, the next tables (Table (4-12), (4-14), (4-16)) resume the statistical paired t test.

Furthermore, Pearson correlation analysis was utilized to assess the strength and direction of the linear relationships among nurses' knowledge, attitudes, and practices concerning diabetic foot care, both before and following the implementation of the online educational program, the next table (Table 4-18) resume the statistical Pearson correlation analysis.

The relationship between the concepts of Amit Jain's PENTAGON model for diabetic foot care among Jordanian nurses was analyzed before and after the online educational program using the paired t-test. This test is ideal for comparing the means of the same group at two different time points, making it well-suited for this study. The paired t-test was important, as it identified whether any changes in nurses' understanding and application of the PENTAGON model were statistically significant, thus evaluating the program's

effectiveness, the next table (Table 4-20) resume the statistical paired t-test.

Additionally, the results provided valuable insights that could guide the development of future educational programs in diabetic foot care. The significance level for all statistical tests was set at $p < .05$.

Table 3-1 Statistical Tests

Statistical Test	Dependent vs. Independent Variable	Type of Variable	Research Questions
Descriptive analysis (median).	Knowledge is considered a dependent variable.	Categorical variable	Determine the levels of knowledge (i.e., adequate knowledge or inadequate knowledge) regarding diabetic foot care among Jordanian nurses' pre- and post-online educational program?
Descriptive analysis (median).	Attitude is considered a dependent variable.	Categorical variable	Determine the level of attitudes (i.e., favorable attitude or non-favorable attitude) regarding diabetic foot care among Jordanian nurses pre- and post-online educational program?
Descriptive analysis (median)	Practice is considered a dependent variable.	Categorical variable	Determine the level of practice (i.e., sufficient practice or insufficient practice) regarding diabetic foot care among Jordanian nurses pre- and post-online educational programs?
A paired-sample *t*-test	Knowledge is considered a dependent variable.	Continuous variable	Does attending an online educational program improve the knowledge scores of Jordanian nurses regarding diabetic foot care?"
	Demographic characteristics are considered independent variables.	Categorical variables	
A paired-sample *t*-test	Attitude is considered dependent variables.	Continuous variable	Does attending an online educational program improve the attitude scores of Jordanian nurses regarding diabetic foot care?"

Statistical Test	Dependent vs. Independent Variable	Type of Variable	Research Questions
	Demographic characteristics are considered independent variables.	Categorical variables	
A paired-sample *t*-test	Practice is considered a dependent variable.	Continuous variable	Does attending an online educational program improve the practice scores of Jordanian nurses regarding diabetic foot care?"
	Demographic characteristics are considered independent variables.	Categorical variables	
ANOVA	Knowledge is considered a dependent variable; demographic characteristics are considered an independent variable.	Dependent and Independent variables considered a categorical variable	What is the relationship between knowledge levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre- and post-online educational program?
ANOVA	Attitude is considered a dependent variable; demographic characteristics are considered an independent variable.	Dependent and Independent variables considered a categorical variable	What is the relationship between attitude levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre- and post-online educational program?

Statistical Test	Dependent vs. Independent Variable	Type of Variable	Research Questions
ANOVA	Practice is considered a dependent variable; demographic characteristics are considered an independent variable.	Dependent and Independent variables considered a categorical variable	What is the relationship between practice levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre- and post-online educational program?
Pearson's correlation coefficient	Knowledge, attitude, and practice.	Continuous variable	Is there a relationship between the levels of knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre- and post-online educational program?
A paired-sample *t*-test	Concepts of Amit Jain's diabetic foot PENTAGON	Continuous variable	Is there a relationship between the concepts of Amit Jain's diabetic foot "PENTAGON "model among Jordanian nurses pre- and post-online educational program?

3.13 Summary of Chapter Three: Methodology

This study, titled "Effectiveness of an Online Educational Program Towards Diabetic Foot Care on Nurses' Knowledge, Attitude, and Practice in Jordan," evaluated the impact of an online educational intervention on nurses' knowledge, attitudes, and practices regarding diabetic foot care. A quasi-experimental, one-group pre-test/post-test design was employed. The study was conducted in selected governmental hospitals under the Ministry of Health (MOH) located in the northern, middle, and southern regions of Jordan.

Hospitals were selected based on the availability of departments relevant to diabetic foot care, including ICUs, general surgical and medical wards, diabetic clinics, emergency departments, and outpatient clinics. A convenience sampling technique was used, with 130 questionnaires distributed and 115 returned, yielding a 90% response rate. Inclusion criteria required nurses to have at least three months of clinical experience in the targeted departments. Exclusion criteria included nursing students, administrative nurses not involved in direct patient care, and those unavailable or unwilling to participate.

Validated questionnaires from previous studies were used to assess knowledge, attitudes, and practices (KAP) toward diabetic foot care. The tools were reviewed for content validity by a panel of experts in Jordan and were pilot-tested on 10% of the sample to ensure clarity and appropriateness. The attitudes section demonstrated strong internal consistency with a Cronbach's alpha of .858.

The intervention was delivered online via Google Meet and was based on Amit Jain's PENTAGON model and the IWGDF guidelines. Pre-intervention data were collected in person to ensure engagement and data reliability, while post-intervention data were gathered via email to align with the online nature of the training. Data collection took place between February and April 2024.

For data analysis, SPSS version 24.0 was used. After data cleaning to remove outliers and incomplete responses, descriptive statistics were conducted to report medians, percentages, and frequencies for categorical variables, and means with standard deviations for continuous variables. A significance level of $p < .05$ was applied.

A paired-sample t-test was used to compare knowledge, attitude, and practice scores before and after the educational program, as this test is appropriate for analyzing related groups. ANOVA was applied to examine associations between nurses' demographic variables and their KAP scores pre- and post-intervention. Pearson correlation analysis was conducted to assess the strength and direction of relationships among knowledge, attitudes, and practices. Additionally, a paired-sample t-test was used to evaluate changes in nurses' understanding and application of the PENTAGON model before and after the training, providing insight into the program's effectiveness. These results contribute to evidence-based recommendations for future educational interventions in diabetic foot care.

4 CHAPTER FOUR: THE RESULTS

4.1 Chapter Overview

In this chapter, the study results focusing on the analysis of the research data collected will be portrayed. The main purposes of this chapter are to describe the demographic characteristics of the participants who participated in the study and revealed the results of the analyses of the following: (a) the knowledge of DFU of nurses in Jordan pre and post online educational program, (b) the attitudes toward DFU of nurses in Jordan pre and post online educational program, (c) the practices of DFU of nurses in Jordan pre and post online educational programs , (d)Also, to further investigation the association between levels of knowledge, attitude, and practice of nurses and their demographic characteristics regarding diabetic foot care pre and post the online educational program.(E) a relationship between the knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre and post online educational programs, (F) a relationship between the concepts of Amit Jain`s Diabetic Foot "PENTAGON ”Model among Jordanian nurses pre and post online educational program

For these purposes, descriptive statistical analysis with median values were presented and used to determine the levels of knowledge, attitude, and practice of Jordanian nurses on the care of diabetic foot conditions both before and after their participation in an online educational program. In the median test, scores for both groups were combined, and an overall median was calculated. The median is the point in a distribution above or below which 50% of cases fall. One essential feature of the median is that it does not consider the quantitative values of scores. The medium measures the average positions in a distribution. Additionally, it is insensitive to extreme values (Polit & Beck, 2017). A paired-sample T-test was also utilized to investigate further, analyzing the levels of knowledge, attitude, and practice scores among nurses prior to and after an online educational program on DFU. This test of analysis was chosen because it is appropriate for comparing the means of two related groups. A paired T-test is one of the parametric approaches for detecting differences between group means. Furthermore, the T-test was utilized when the sample was paired, as in the current study, where pre-educational and post-educational program scores were compared for the same group (Polit & Beck, 2017).

In addition, to explore the association between knowledge, attitudes, and practice levels of nurses and their demographic characteristics regarding pre- and post-online educational program participation, a combination of descriptive statistics and Analysis of Variance (ANOVA) was employed. Descriptive statistics were used to summarize the mean and standard deviation (SD) of the knowledge, attitude, and practice scores across different demographic groups, providing a general overview of the data. The standard deviation is the most commonly used measure of variability for interval or ratio-level data. It reflects how much individual scores deviate, on average, from the mean value, and every score in the dataset is used in its calculation, similar to the mean (Polit & Beck, 2017).

ANOVA, a parametric statistical test, was used to examine whether there were statistically significant differences in the mean knowledge, attitude, and practice scores among nurses across various demographic categories (Polit & Beck, 2017).

Furthermore, Pearson correlation analysis was utilized to assess the strength and direction of the linear relationships among nurses' knowledge, attitudes, and practices concerning diabetic foot care, both before and following the implementation of the online educational program. This statistical method is well-suited for evaluating the association between continuous variables, providing valuable insight into whether enhancements in knowledge are accompanied by corresponding shifts in attitudes and practices. Employing this analysis is crucial for evaluating the effectiveness of the educational intervention, as it highlights the extent to which its components are interrelated. Such understanding is vital for guiding future educational strategies aimed at improving diabetic foot care practices among nursing professionals.

The relationship between the concepts of Amit Jain's "PENTAGON" model for diabetic foot care among Jordanian nurses was analyzed before and after the online educational program using the Paired t-test. This test is ideal for comparing the means of the same group at two different time points, making it well-suited for this study. The Paired t-test is important as it identifies whether any changes in nurses' understanding and application of the PENTAGON model are statistically significant, thus evaluating the program's effectiveness. Additionally, the results provide valuable insights that can guide the development of future educational programs in diabetic foot care. The significance level for all statistical tests was set at $p < 0.05$.

4.2 Description of the Study Sample

From eleven governmental hospitals in Jordan, a total of 115 nurses who completed the online educational program and worked in one of the six areas of practice (surgical ward, medical ward, ICU unit, emergency room, diabetic foot clinic\diabetic clinic, and outpatient clinic) were invited to participate in this study. The demographic characteristics of participants who completed the online educational program are presented in Table 4-1.

Table 4-1 Demographic Characteristics of Participants (n = 115)

Regions/Hospital	Frequency	Percent (%)
AL-Basheer Hospital	6	5.22%
AL-Hussein / Salt Hospital	14	12.17%
AL-Nadeem Hospital	2	1.74%
AL-Zarqa Hospital	7	6.09%
Middle	29	25.20%
Jarash Hospital	9	7.83%

AL-Mafraq Hospital	7	6.09%
Princess Basma Hospital	7	6.09%
North	23	20.0%
AL-Karak Hospital	12	10.43%
Maan Hospital	30	26.09%
Queen Rania Hospital	5	4.35%
Tafeileh Hospital	16	13.91%
South	63	54.8%
Total	115	100%
Age	Frequency	Percent (%)
20-30 years	84	73%
31-40 years	31	27%
Total	115	100%
Gender	Frequency	Percent (%)
Female	73	63.5%
Male	42	36.5%
Total	115	100%
Current Working Unit	Frequency	Percent (%)
Surgical Ward	27	23.5%
Medical Ward	18	15.7%
ICU Unit	24	20.9%
Emergency Room	27	23.5%
Diabetic Foot Clinic \ Diabetic Clinic	11	9.6%
Outpatient clinic	8	7%
Total	115	100%
Level of Nurse Qualification	Frequency	Percent (%)

Basic Diploma	16		13.9%	
Bachelor`s Degree	87		75.7%	
Master and above	12		10.4%	
Total	115		100%	
Nursing Experience	Frequency		Percent (%)	
≤ 5 years	82		71.3%	
6-10 years	18		15.7%	
11-15 years	9		7.8%	
16-20 years	6		5.2%	
Total	115		100%	
Level of Knowledge of Wound Care	Frequency		Percent (%)	
	Pre	Post	Pre (%)	Post (%)
Excellent knowledge	6	55	5%	48%
Good knowledge	33	42	29%	37%
Satisfactory knowledge	24	18	21%	16%
Fair knowledge	26	0	23%	0%
Poor knowledge	26	0	23%	0%
Total	115	115	100%	100%
Special Training in Wound Care	Frequency		Percent (%)	
	Pre	Post	Pre (%)	Post (%)
Yes	77	115	67%	100%
No	38	0	33%	0%
Total	115	115	100%	100%

Table 4.1 displays the distribution of nurses across different regions shows that the South region has the highest representation, accounting for 54.78% of the total nurses. This includes nurses from Maan Hospital (26.09%), Tafeileh Hospital (13.91%), AL-Karak Hospital (10.43%), and Queen Rania Hospital (4.35%). The Middle region follows with 31.30% of the nurses. This

region includes AL-Basheer Hospital (5.22%), AL-Hussein/Salt Hospital (12.17%), AL-Mafraq Hospital (6.09%), AL-Nadeem Hospital (1.74%), and AL-Zarqa Hospital (6.09%). Finally, the North region represents 13.91% of the total nurses. This includes nurses from Jarash Hospital (7.83%) and Princess Basma Hospital (6.09%).

Regarding age distribution, the majority of nurses (73%) are between the ages of 20 and 30, while (27%) are in the 31-40 age group. In terms of gender, female nurses make up the majority (63.5%), while male nurses account for (36.5%).

In the current study, (67%) of nurses had special training in wound care, such as Diabetic Foot Care pre-educational training. After the program, all nurses (100%) reported having received specialized wound care training. Regarding nurse qualifications, the majority of the nurses held a bachelor's degree (75.7%), while 13.9% have a Basic Diploma. Nurses with a Master’s degree or higher represent (10.4%). Before training, only 6 nurses (5%) assessed their wound care knowledge as excellent, but this number increased to 55 (48%) after training, signifying a (43%) improvement. Nurses who ranked their knowledge as good rose from 33 (29%) pre-training to 42 (37%) post-training, an additional (8%). The number of nurses whose knowledge was satisfactory decreased from 24 (21%) before training to 18 (16%). There were no nurses who considered their knowledge fair before or after the program, unlike the initial figure that stood at 26 (23%). Poorly knowledgeable nurses dropped from 26 (23%) before training to zero after training.

In terms of nursing experience, approximately (71.3%) of nurses have ≤ 5 years of nursing experience. Additionally, (15.7%) have 6-10 years of experience, while (7.8%) have 11-15 years. The least represented groups are those with 16-20 years (5.2%). Our study found that nurses have many different workplaces: 27 (23.5%) worked in a surgical ward, 18 (15.7%) in a medical ward, 24 (20.9%) in an ICU, 27 (23.5%) worked in an emergency unit, 11 (9.6%) in a diabetic foot clinic\diabetic clinic, and 8 (7%) in an OPC.

4.3 Research Questions and Hypothesis

4.3.1 The First Research Question:

Determine the levels of knowledge (i.e., Adequate Knowledge & Inadequate Knowledge) regarding diabetic foot care among Jordanian nurses’ pre and post online educational programme?

Table 4-2 Levels of knowledge (n = 115)

Levels of knowledge / Education Period	Adequate Knowledge (≥ Median)	Inadequate Knowledge (< Median)
Pre educational	53 (46.09%)	62 (53.91%)
Post educational	72 (62.61%)	43 (37.39%)

Note: Pre Knowledge levels based on median = 5
Note: Post Knowledge levels based on median = 11

A descriptive statistical analysis was performed to assess nurses' knowledge level of DFU before and after an online educational program. Table 4-2, shows that the median score for nurses' knowledge pre-educational program was 5.00, while the median score for nurses' knowledge post-educational program was 11.00. The nurses' knowledge of DFU was examined using fourteen questions, with the lowest and highest total scores possible being 0 and 14, respectively.

Table 4-2 presents the knowledge levels of Jordanian nurses on the care of diabetic foot conditions both before and following their participation in an online educational program. "Adequate Knowledge" (scores ≥ the median) and "Inadequate Knowledge" (scores < the median) are the categories.

4.3.1.1 Levels of Knowledge Pre-Educational Programme:

less than half of the 53 nurses (46.09%) had adequate knowledge of diabetic foot care before participating in an online educational program. On the other hand, before this intervention, 62 nurses (53.91%) had inadequate knowledge, did not possess a comprehensive comprehension of diabetic foot care.

4.3.1.2 Levels of Knowledge Post-Educational Programme:

However, 72 nurses (62.61%) had adequate knowledge following the online educational program, indicating a significant improvement. Most nurses should now be knowledgeable about managing diabetic foot care. The total number of nurses with Inadequate knowledge decreased to 43 (37.39%), reflecting positively upon such educational programs offered online.

Table 4-3 Repones Rate of Participants for Knowledge Section: Pre and Post Educational Program

	Item of Knowledge Section	Pre (*n*)	*R. R (100%)*	Post (*n*)	*R. R (100%)*
1.	I think diabetic ulcer treatment is more important than ulcer prevention.	25	22%	85	74%
2.	I do not think it is necessary to assess diabetic wounds regularly.	16	14%	90	78%
3.	Neuropathy is the predominant factor responsible for diabetic ulcers.	46	40%	89	77%
4.	Sensory neuropathy may results ulcers forming.	45	39%	98	85%
5.	Neuropathy is associated with dry skin which predisposes to ulcer formation.	44	38%	84	73%
6.	Diabetic neuropathic ulcers are typically found on weight bearing areas of the foot.	47	41%	90	78%
7.	Neuropathy can be excluded if the foot skin is cool and pulses are absent.	50	43%	77	67%
8.	The risk of amputation is higher when diabetic foot ulcer is associated with limb ischemia.	51	44%	93	81%
9.	Presence of slough is not an indication of infection in diabetic ulcers.	54	47%	82	71%
10.	Presence of osteomyelitis impairs healing of diabetic ulcers.	42	37%	89	77%
11.	Change to off-loading treatment should facilitate ulcer healing.	46	40%	91	79%
12.	Infected wounds should be cleansed daily.	45	39%	92	80%
13.	Dressings are effective in healing wounds with clinical signs of infection.	42	37%	94	82%
14.	Hydrogel dressings are useful to rehydrate the wound bed and control the moisture in wounds.	41	36%	92	80%

Table 4-3: Presents the number of nurses who correctly answered each question related to knowledge of diabetic ulcer care, both before and after the educational program, out of a total sample size of 115. The data indicates a substantial improvement in knowledge across all questions after the program.

Before the program, only 25 (22%) nurses correctly identified that ulcer prevention is more important than treatment. After the program, this number improved to 85(74%), showing a better understanding of prevention as a critical aspect of diabetic care. Only 16 (14%) nurses knew that regular assessment of diabetic wounds is necessary pre-program, but post-program, 90 (78%) nurses answered this question correctly, highlighting improved awareness of the importance of

continuous monitoring. The number of nurses who correctly identified neuropathy as the predominant factor responsible for diabetic ulcers increased from 46(40%) to 89 (77%) post-programs, indicating better comprehension of underlying causes. Knowledge that sensory neuropathy can result in ulcer formation improved from 45 (39%) correct answers pre-program to 98 (85%) post-programs, nearly universal among the nurses. Understanding that neuropathy leads to dry skin, which predisposes to ulcer formation, increased from 44 (38%) to 84 (73%) correct responses, showing enhanced recognition of early signs. Knowledge that diabetic neuropathic ulcers are typically found on weight-bearing areas of the foot increased from 47 (41%) to 90 (78%) correct responses, indicating improvement in this practical knowledge. The number of nurses who correctly answered that neuropathy cannot be excluded if the foot skin is cool and pulses are absent decreased from 50 (43%) to 77 (67%) post-programs, which still reflects a substantial improvement in understanding this diagnostic challenge. Understanding that the risk of amputation is higher when a diabetic foot ulcer is associated with limb ischemia improved from 51(44%) to 93 (81%) correct responses, highlighting an increased awareness of severe complications. The number of nurses who understood that the presence of slough does not necessarily indicate infection in diabetic ulcers increased from 54 (47%) to 82 (71%) post-programs, showing improved knowledge of wound characteristics.

Awareness that the presence of osteomyelitis impairs the healing of diabetic ulcers increased from 42 (37%) to 89 (77%) correct responses, indicating a stronger grasp of the impact of infections on healing. The number of nurses who correctly identified that off-loading treatment facilitates ulcer healing increased from 46 (40%) to 91(79%) post-programs, indicating better understanding of pressure-relief strategies. The knowledge that infected wounds should be cleansed daily improved significantly from 45 (39%) to 92 (80%) correct responses, showing better adoption of proper wound care practices. Understanding that dressings are effective in healing wounds with clinical signs of infection improved from 42 (37%) to 94 (82%) correct responses, highlighting improved knowledge of appropriate wound care. Knowledge that hydrogel dressings are useful for rehydrating the wound bed and controlling moisture increased from 41(36%) to 92 (80%) correct responses, showing better awareness of advanced wound care techniques.

4.3.2 The First Research Hypothesis:

Null Hypothesis (H0): Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the knowledge mean score post online educational program implementation.

Alternative Hypothesis (HA): Jordanian nurses attending the online educational program regarding diabetic foot care will improve the knowledge mean score post online educational program implementation.

To determine the effectiveness of the online educational program, a paired-sample t-test was used to analyze the knowledge scores pre- and post-online educational program of Jordanian nurses regarding diabetic foot care. This type of analysis was chosen because it is suitable for comparing the means of two related groups. In this case, the pre- and post-intervention scores of the same group of nurses were compared to assess any significant changes in their knowledge levels resulting from the online educational program.

Table 4-4 Paired Samples T -Test Results for Pre and Post Knowledge Scores

Assessment of Knowledge	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pre	5.1652	2.03879	26.693	114	<0.001*
Post	10.83	2.115			

Note: *$p < .05$ ** $p < 0.01$

The analysis revealed a significant improvement in the knowledge levels of nurses after the educational intervention. The mean score for the pre-assessment of knowledge was 5.1652, while the mean score for the post-assessment of knowledge was 10.83. This substantial increase indicates that the online educational program was effective in enhancing the nurses' knowledge about diabetic foot care.

The statistical analysis further supported these findings. The t-value of 26.693 indicated a very large effect size, and the p-value (Sig. 2-tailed) was <0.001, which is well below the conventional alpha level of 0.05. Consequently, the null hypothesis (H0) was rejected in favor of the alternative hypothesis (HA).

4.3.3 The Second Research Question:

Determine the level of attitudes (i.e., favorable attitude & non-favorable attitude) regarding diabetic foot care among Jordanian nurses pre and post online educational program?

Table 4-5 Levels of Attitude (n = 115)

Levels of Attitude / Education Period	Favorable Attitude (≥ Median)	Non-Favorable Attitude (< Median)
Pre educational	60 (52.17%)	55 (47.83%)
Post educational	70 (60.87%)	45 (39.13%)

Note: Pre Attitude levels based on median = 25

Note: post Attitude levels based on median = 29

A Table 4-5 shows the data regarding Jordanian nurses' attitudes to diabetic foot care before and after an online educational learning program. The attitude scores ranged from extremely negative (8) to extremely positive (40). The nurses' attitudes toward DFC were assessed through 8 questions answered on a five-point Likert ranging from one to five, in which one means "Strongly Disagree," and five means "Strongly Agree." the median score for nurses' attitude pre-educational program was 25.00, while the median score for nurses' attitude post-educational program was 29.00. Based on the median, the attitudes are categorized as either having a favorable attitude (scores ≥ median) or a non-favorable attitude (scores < median). as illustrated in Table 4.5.

4.3.3.1 Levels of Attitude pre-educational programme:

Prior to the online educational program, sixty nurses (52.17%) had a favorable attitude towards diabetic foot care. While, 55 nurses (47.83%) had non-favorable attitudes concerning diabetic foot care as illustrated in Table 4-5.

4.3.3.2 Levels of Attitude post-educational programme:

After to the online educational program, seventy (70) out of hundred fifteen (115) nurses (60.87%) achieved a favorable attitude. Whereas, 45 nurses (39.13%) had a non-favorable attitude towards diabetic foot care as illustrated in Table 4-5.

Table 4-6 Assessment of Nurses' Attitudes: Pre and Post Educational Program

Assessment of Attitude	Pre		Post	
	Mean	Std. Deviation	Mean	Std. Deviation
1. Diabetic wound care is time consuming me to carry out.	3.39	1.10	4.32	0.80
2. In comparison with other areas of nursing care, diabetic wound care is a low priority task for me.	3.22	1.15	1.92	1.18
3. If I have the opportunity, I would like to avoid to caring diabetic wounds.	3.48	1.00	1.72	1.14
4. I have time to advice each patient individually on how to look 1 their wounds.	3.17	1.12	3.68	0.98
5. It is my responsibility to educate patients with diabetic ulcers on how to reduce re-ulceration.	3.01	1.14	4.44	0.73
6. I think about pain when cleaning diabetic	2.90	1.17	3.79	0.83

wounds.				
7. I like to care for diabetic wound in my practice.	2.97	1.17	4.45	0.79
8. I am satisfied with caring diabetic wounds.	2.99	1.17	4.26	0.85
average Assessment of Attitude	3.14	0.42	3.57	0.36

This table presents a comparison of nurses' attitudes toward diabetic wound care before and after participating in an online educational program. The data indicates clear improvements in various aspects of their attitudes, as reflected in the mean scores.

Time consumption: Nurses initially found diabetic wound care time-consuming, with a pre-program mean score of 3.39, which increased to 4.32 post-program, suggesting greater acceptance of the time required.

Priority of care: Initially, nurses viewed diabetic wound care as a low-priority task (mean 3.22), but post-program, this perception shifted significantly to a much lower mean of 1.92, indicating an increased recognition of the importance of diabetic wound care.

Avoidance of care: Before the program, nurses showed a moderate desire to avoid diabetic wound care (mean 3.48). However, post-program, this desire decreased drastically to 1.72, suggesting a higher willingness to engage in this care.

Individualized advice: Nurses’ perception of having enough time to provide individualized advice improved from a mean of 3.17 to 3.68, showing a better understanding of the importance of patient education.

Responsibility in patient education: A strong increase in nurses' sense of responsibility to educate patients about ulcer prevention is evident, with the mean score increasing from 3.01 to 4.44.

Concern about pain: Nurses became more considerate about patients' pain during wound cleaning, with the mean increasing from 2.90 to 3.79 post-program.

Enjoyment in care: Nurses' enjoyment of diabetic wound care increased substantially, from 2.97 to 4.45, reflecting a more positive attitude toward this practice.

Satisfaction with care: Similarly, satisfaction with caring for diabetic wounds rose from 2.99 to 4.26, indicating enhanced job satisfaction in this area post-training. Overall, the average attitude score improved from 3.14 pre-program to 3.57 post-program.

4.3.4 The Second Research Hypothesis:

Null Hypothesis (H0): Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the attitude mean score post online educational program implementation.

Alternative Hypothesis (HA): Jordanian nurses attending the online educational program regarding diabetic foot care will improve the attitude mean score post online educational program implementation.

To determine the effectiveness of the online educational program in improving the attitudes of Jordanian nurses towards diabetic foot care, a paired-sample t-test was employed. This statistical test is appropriate for comparing the means of two related groups, which in this case are the pre- and post-intervention attitude scores of the same group of nurses. By using this test, we can assess whether there has been a significant change in the attitudes of the nurses after participating in the educational program.

Table 4-7 Paired Samples T- Test Results for Pre and Post Assessment of Attitude

Assessment of Attitude	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pre	3.1402	0.42281	10.570	114	<0.001*
Post	3.5739	0.36270			

Note: *$p < .05$ ** $p < 0.01$

The analysis showed a significant improvement in the attitudes of nurses after the educational intervention. The mean score for the pre-assessment of attitude was 3.1402, while the mean score for the post-assessment of attitude increased to 3.5739. This indicates a positive shift in the nurses' attitudes towards diabetic foot care after the online educational program as illustrated in Table 4-7.

The statistical analysis further confirmed these findings. The t-value of 10.570 suggests a considerable effect size, and the p-value (Sig. 2-tailed) of <0.001 is well below the conventional alpha level of 0.05. This leads us to reject the null hypothesis (H0) and accept the alternative hypothesis (HA), indicating that the online educational program significantly improved the attitude mean score of the nurses as illustrated in Table 4-7.

4.3.5 The third Research Question:

Determine the level of practice (i.e., sufficient practice & insufficient practice) regarding diabetic foot care among Jordanian nurses pre and post online educational programs?

Table 4-8 Levels of Practice (n = 115)

Levels of practice / Education Period	Sufficient practice (≥ Median)	Insufficient practice (< Median)
Pre educational	62 (53.91%)	53 (46.09%)
Post educational	79 (68.70%)	36 (31.30%)

Note: Pre Practice levels based on median = 47
Note: Post Practice levels based on median = 53

Table 48 presents a descriptive statistical analysis was conducted to assess Jordanian nurses' practice levels towards diabetic foot care before and after attending an online education program. The practice is divided into two groups: sufficient practice (scores ≥ median) and insufficient practice (scores < median).

The median score for nurses' practice pre-educational program was 47.00, while the median score for nurses' practice post-educational program was 53.00. The nurses' practices of DFU were assessed through 12 questions answered on a five-point Likert ranging from one ("Never") to five ("Always"). As a result, the lowest and highest total scores were 12 and 60, respectively.

4.3.5.1 Levels of Practice pre-educational programme:

There were 62 (53.91%) nurses who had sufficient practice in diabetic foot care before the educational program; this means that slightly more than half were consistently engaging in sufficient practices related to caring of diabetic foot ulcer. Conversely, 53 nurses (46.09%) did not perform their duties or insufficiently performed them because their practices needed to meet the necessary standards. The pre-program median score was 47. Any nurse who scored 47 and above indicated sufficient practice as illustrated in Table 4-8.

4.3.5.2 Levels of Practice post-educational programme:

After attending the online education program, a total number of nursing staff having sufficient practices increased to 79(68.70%). This represents considerable improvement whereby a larger proportion adhered to proper diabetic foot care practices. Conversely, Insufficient Practice number subsequently decreased by 36 (31.30%). The post-program median score was found to be 53, those scoring above this value were considered as having practiced enough after being trained as illustrated in Table 4-8.

Table 4-9 : Assessment of Nurses' Practice: Pre and Post Educational Program

Assessment of Practice	Pre		Post	
	Mean	Std. Deviation	Mean	Std. Deviation
1. I assess patients at risk for diabetic foot ulcer for signs, like pain, skin, vascular status, and loss of protective sensation and check for deformities.	3.98	0.94	4.39	0.83
2. I assess foot ulcer wound for depth, length and size.	3.72	1.07	4.35	0.95
3. Assess of muscular skeletal system for patient during diabetic foot care.	3.70	0.94	4.34	0.89
4. I can assess foot for hygiene (cut toenails, unwashed feet, superficial fungal infection and unclean socks).	4.34	0.95	4.03	0.70
5. I assess patient for physical limitation such as visual acuity and obesity.	4.42	0.96	4.00	0.76
6. I perform education session for patient and family.	4.08	1.05	4.03	0.71
7. Ensure routine wearing of appropriate foot wear (wide, without excessive pressure of skin, style condition and fit).	3.83	0.94	4.61	0.72
8. I debride necrotic tissue and the surrounding callus.	3.65	1.17	4.48	1.00
9. I select appropriate dressing according to diabetic foot ulcer condition.	3.73	1.05	4.59	0.82
10. I clean nails with appropriate instrument or nail cutter.	3.59	1.06	4.48	0.93
11. I measure patient feet size when last bought foot wears.	3.58	1.16	4.47	0.99
12. Using the appropriate offloading devices.	3.70	1.02	4.32	0.97
Assessment of Practice	3.86	0.57	4.34	0.41

This table illustrates the comparison of nurses' practices in diabetic foot care before and after their participation in an online educational program. The data shows a marked improvement in various practical aspects of diabetic foot care, as indicated by the mean scores.

Assessment of patients at risk: The practice of assessing patients for diabetic foot ulcer risks, including signs such as pain and vascular status, improved from a pre-program mean of 3.98 to 4.39, showing enhanced attention to early detection.

Wound assessment: Nurses improved their practice in assessing the depth, length, and size of foot ulcers, with the mean increasing from 3.72 to 4.35.

Musculoskeletal assessment: The improvement in the post-program mean score, which increased from 3.70 before the program to 4.34 after the program, is attributed to the enhanced assessment of the musculoskeletal system during foot care of diabetics.

Hygiene assessment: There was a slight decrease from 4.34 to 4.03, in h-p/hygiene assessment of the feet (toenail, fungal diseases, etc.) suggesting that those skills were not impaired, but more attention was given to other activities after the training program.

Physical limitations: The result of such practices as determining visual acuity and body mass ratios recorded a mean decrease from 4.42 to 4.00 which means that most professionals could have diverted their focus to other professions.

Patient education: There was no significant change on the effectiveness of providing families and patients with educational sessions which showed a slight decrease of 4.08 to 4.03.

Footwear assessment: Providers improved their techniques toward ensuring appropriate footwear usage by an increase on the mean score from 3.83 to 4.61.

Debridement of necrotized tissue: There was increase in application of basic wound debridement among nurses that improved from a score of 3.65 to 4.48.

Dressing selection: There was a valid and statistically significant improvement in nurses' capacity to select the proper dressings for diabetic foot ulcers as the mean scores jumped from 3.73 to 4.59.

Nail care: A significant improvement took place upon the increase of nail cleaning with the use of the appropriate tools from 3.59 to 4.48, indicating a better management of hygiene.

Foot size measurement: The mean on the measurement scale also increased from 3.58 to 4.47 suggesting that nurses paid more attention to the measurement of foot size when choosing the correct footwear for patients.

Use of offloading devices: There was a general improvement for the mean scale of the use of the correct offloading devices which are important in reducing pressure on the foot from 3.70 to

4.32. Generally, there was a change in the average practice score which moved from a score of 3.86 pre-program to the new score of 4.34 which is post program.

4.3.6 The Third Research Hypothesis:

Null Hypothesis (H0): Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the practice mean score post online educational program implementation.

Alternative Hypothesis (HA): Jordanian nurses attending the online educational program regarding diabetic foot care will improve the practice mean score post online educational program implementation.

To evaluate the effectiveness of the online educational program in improving the practices of Jordanian nurses regarding diabetic foot care, a paired-sample t-test was utilized. This statistical test is appropriate for comparing the means of two related groups, in this case, the pre- and post-intervention practice scores of the same group of nurses. This analysis helps to determine if there is a significant change in the practice levels of nurses after the educational intervention.

Table 4-10 Paired Samples T-Test Results for Pre and Post Assessment of Practice

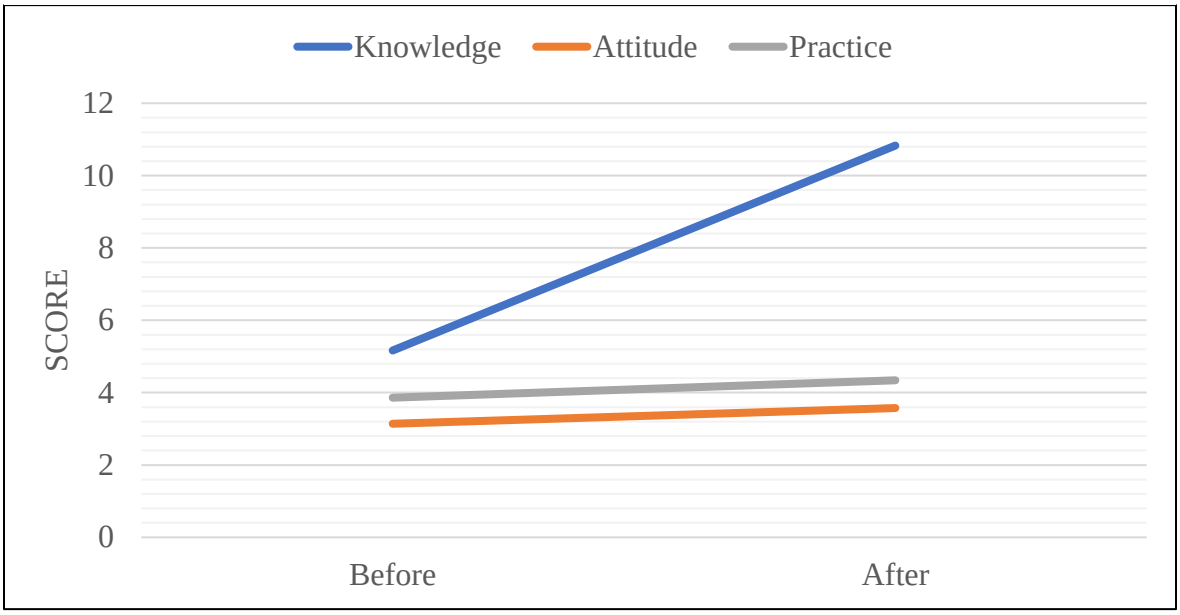
Assessment of Practice	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pre	3.861594	0.569691	13.536	114	<0.001*
post	4.341304	0.410328			

Note: *$p < .05$ ** $p < 0.01$

The analysis demonstrated a significant improvement in the practice levels of nurses after the educational intervention. The mean score for the pre-assessment of practice was 3.861594, while the mean score for the post-assessment of practice increased to 4.341304. This indicates a notable enhancement in the nurses' practices regarding diabetic foot care following the online educational program as illustrated in Table 4-10.

The statistical analysis further supported these findings. The t-value of 13.536 indicates a substantial effect size, and the p-value (Sig. 2-tailed) of <0.001 is well below the conventional alpha level of 0.05. Consequently, the null hypothesis (H0) is rejected in favor of the alternative hypothesis (HA), confirming that the online educational program significantly improved the practice mean score of the nurses as illustrated in Table 4-10.

Figure 4.3-2 The Linear Trend of Knowledge, Attitude, And Practice Scores Before and after the Educational Program



4.3.7 The Forth Research Question:

What is the relationship between knowledge levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program?

The Forth Research Hypothesis:

Null Hypothesis (H0): There is no a relationship between knowledge levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Alternative Hypothesis (HA): There is a relationship between knowledge levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Table 4-11Association between knowledge levels of nurses' and demographic characteristics BEFORE educational program

Characteristic		Mean	SD	Test statistic	Df	Sig. (2-tailed)
Region	Middle (n=29)	5.00	2.04	F = 0.156	2, 112	.856*
	North (n=23)	5.13	1.74			
	South (n=63)	6.00	2.16			
Age	20-30 y (n=84)	5.20	2.03	t = 0.301	113	.764*

	31-40 y (n=31)	4.40	2.13			
Gender	Female (n=73)	4.90	1.86	t = -1.051	113	.295*
	Male (n=42)	5.90	2.31			
Current Working Unit	Surgical (n=27)	6.20	1.84	F = 1.168	5, 109	.330*
	Medical (n=18)	4.10	1.92			
	ICU (n=24)	6.00	1.37			
	ER (n=27)	4.30	2.33			
	DM clinic (n=11)	5.80	3.39			
	OP clinic (n=8)	4.50	1.46			
Qualification	Diploma (n=16)	4.20	2.70	F = 0.890	3, 111	.449*
	BS (n=87)	5.60	1.84			
	MS or above (n=12)	6.90	2.47			
Nursing Experience	≤ 5 y (n=82)	5.40	2.08	F = 1.927	4, 110	.111*
	6-10 y (n=18)	4.20	1.69			
	11-15 y (n=9)	6.10	2.03			
	16-20 y (n=6)	6.50	0.96			

Note: *$p < .05$ ** $p < 0.01$

Interpretation of Table 4-11 – Before the online educational program was introduced, the data showed no statistically significant relationships between nurses' knowledge levels about diabetic foot care and any of their demographic characteristics. For example, when comparing knowledge scores across different regions, the results were not significant (F = 0.156, p = .856), suggesting that nurses from the Middle, North, and South of Jordan had similar levels of knowledge at baseline. Age also didn't appear to make a difference; nurses aged 20–30 and those aged 31–40 had comparable knowledge levels, with the t-test yielding t = 0.301 and p = .764.

Gender differences were likewise not statistically meaningful. Although male nurses had slightly higher mean scores than female nurses, the difference wasn't significant (t = -1.051, p = .295). Looking at nurses' current work units—whether surgical, medical, ICU, ER, diabetes clinics, or outpatient clinics—there was no notable variation in knowledge scores (F = 1.168, p = .330). Similarly, academic qualifications didn't play a significant role. Whether nurses held a

diploma, bachelor's, or master's degree, their knowledge levels were statistically similar (F = 0.890, p = .449).

Finally, years of nursing experience didn't appear to influence knowledge either. The ANOVA test for this variable (F = 1.927, p = .111) indicated that nurses with varying levels of experience, from early-career to those with over 15 years in the field, had comparable scores.

Altogether, these findings support the null hypothesis, indicating that prior to the educational intervention, there were no significant differences in knowledge based on demographic factors. Practically speaking, this highlights a widespread gap in knowledge among Jordanian nurses about diabetic foot care, regardless of background or experience. It also reinforces the need for a comprehensive, inclusive educational initiative targeting all nurses equally.

Table 4-12 Association between knowledge levels of nurses' and demographic characteristics AFTER educational program

Characteristic		Mean	SD	Test statistic	df	Sig. (2-tailed)
Region	Middle (n=29)	11.8	2.31	F = 4.667	2, 112	0.011*
	North (n=23)	10.2	2.3			
	South (n=63)	10.4	2.04			
Age	20-30 y (n=84)	10.2	2.14	t = -2.112	111	0.037*
	31-40 y (n=31)	11.4	2.02			
Gender	Female (n=73)	10.1	2.22	t = -2.895	113	0.005*
	Male (n=42)	11.8	1.87			
Current Working Unit	Surgical (n=27)	12.2	2.1	F = 3.029	5, 109	0.013*
	Medical (n=18)	9.8	2.13			
	ICU (n=24)	11.9	1.61			
	ER (n=27)	9.9	2.23			
	DM clinic (n=11)	10.3	2.87			
	OP clinic (n=8)	11.5	1.75			
Qualification	Diploma (n=16)	9.6	2.77	F = 4.489	3, 111	0.005*
	BS (n=87)	11	1.97			
	MS or above	12.6	1.67			

	(n=12)					
Nursing Experience	≤ 5 y (n=82)	10.3	2.18	F = 3.112	4, 110	0.018*
	6-10 y (n=18)	11.8	1.69			
	11-15 y (n=9)	12.4	2.3			
	16-20 y (n=6)	11.9	2.71			

Note: *$p < .05$ ** $p < 0.01$

Interpretation of Table 4-12 After completing the educational program, the picture changed significantly. Several demographic characteristics were now linked to noticeable differences in nurses' knowledge levels, suggesting that the training had a varied impact across different groups. For instance, regional differences became statistically significant (F = 4.667, p = .011). Nurses from the Middle region scored higher, on average, than those from the North or South, which may reflect differences in engagement with the material or access to supportive resources.

Age also became a significant factor. Nurses in the 31–40 age group outperformed their younger colleagues (t = -2.112, p = .037), perhaps because they brought more professional maturity or clinical experience into the learning process, allowing them to absorb and apply new knowledge more effectively.

Gender differences were observed following the intervention, with male nurses scoring significantly higher than female nurses (t = -2.895, p = .005). This disparity may, in part, be attributed to social and contextual factors, such as the increased family responsibilities often borne by women, including childcare and household duties. These obligations may impact their available time and mental focus, potentially limiting full engagement with the training content. While this remains a possible interpretation, it highlights the need to consider individual circumstances and social dynamics when designing and implementing educational programs, in order to ensure equitable access and effectiveness for all participants.

Differences across work units were also significant after the training (F = 3.029, p = .013). Nurses working in surgical units and ICUs had higher post-test scores than those in medical wards or emergency departments. This could be due to greater relevance of the educational content to their daily responsibilities, or a higher baseline familiarity with wound care practices. Academic qualification made a difference as well. Nurses with a master's degree or higher achieved the highest scores (F = 4.489, p = .005), which isn't surprising given their advanced training and likely greater capacity for critical thinking and knowledge application.

Years of nursing experience also became a key factor (F = 3.112, p = .018). More experienced nurses—particularly those with over 10 years in the profession—scored higher after the program. This trend suggests that clinical experience, when combined with formal education, can enhance learning outcomes and improve knowledge retention.

In summary, these post-training results support the alternative hypothesis, showing that knowledge levels were significantly influenced by demographic characteristics after the educational program. While the program clearly improved overall knowledge, it did so to varying degrees depending on factors like age, gender, experience, and work setting. These insights highlight the importance of tailoring future educational efforts to better meet the needs of different subgroups within the nursing population, ensuring that all nurses benefit equally and effectively.

Figure 4.3-3 Box Plot - Knowledge Levels Before and After by Category

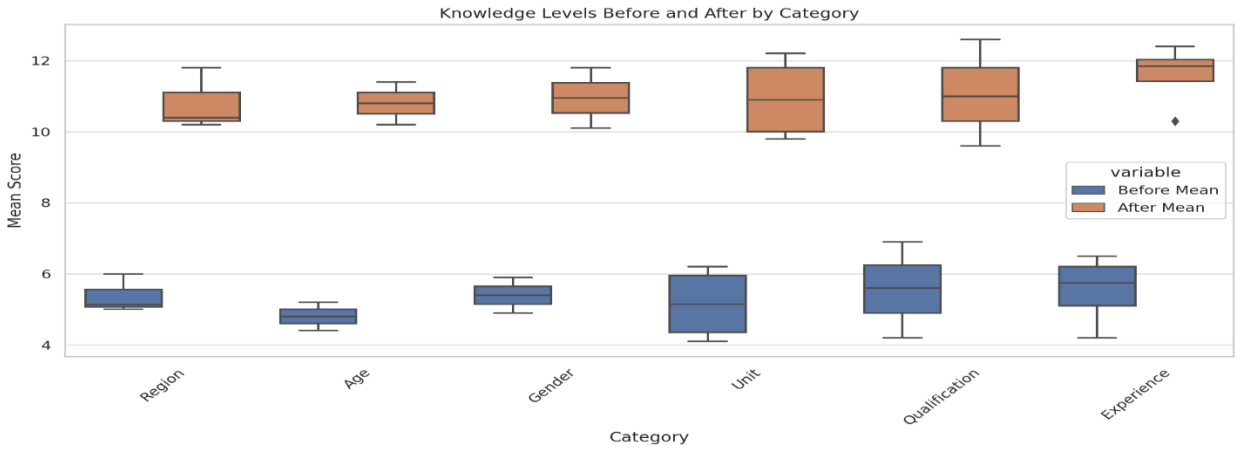
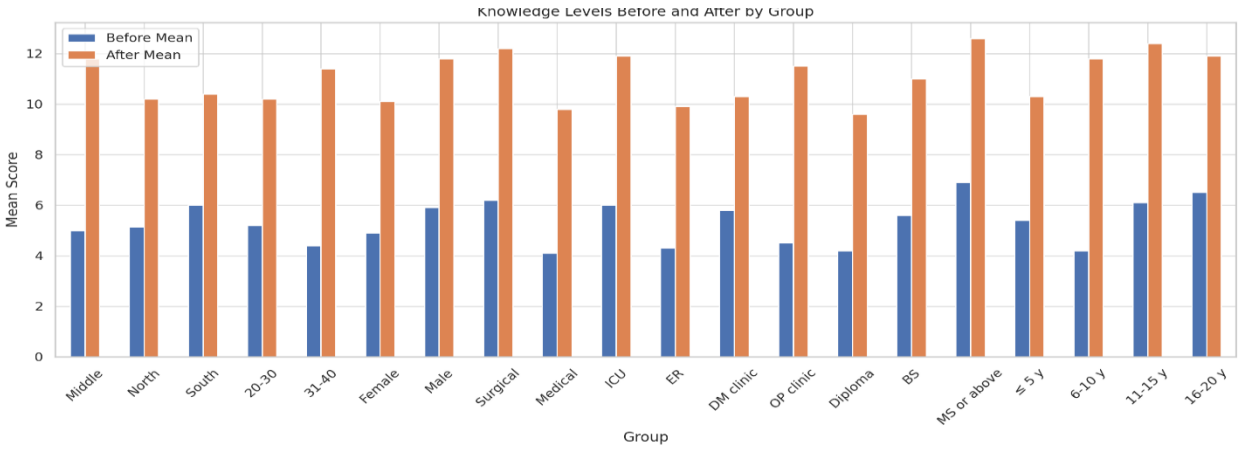


Figure 4.3-4 Bar Chart - Knowledge Levels Before and After by Group



4.3.8 The Fifth Research Question:

What is the relationship between attitude levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program?

4.3.9 The Fifth Research Hypothesis:

Null Hypothesis (H0): There is no a relationship between attitude levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Alternative Hypothesis (HA): There is a relationship between attitude levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Table 4-13 Association between attitude levels of nurses' and demographic characteristics BEFORE educational program

Characteristic		Mean	SD	Test statistic	df	Sig. (2-tailed)
Region	Middle (n=29)	3.16	0.40	F = .162	2, 112	.851*
	North (n=23)	3.10	0.57			
	South (n=63)	3.14	0.38			
Age	20-30 y (n=84)	3.15	0.45	t = .305	111	.761*
	31-40 y (n=31)	3.12	0.37			
Gender	Female (n=73)	3.11	0.40	t = -.851	113	.396*
	Male (n=42)	3.18	0.46			
Current Working Unit	Surgical (n=27)	3.15	0.38	F = .761	5, 109	.580*
	Medical (n=18)	3.20	0.44			
	ICU (n=24)	3.17	0.46			
	ER (n=27)	3.17	0.42			
	DM clinic (n=11)	3.00	0.39			
	OP clinic (n=8)	2.94	0.48			

Qualification	Diploma (n=16)	3.02	0.44	F = .937	2, 111	.425*
	BS (n=87)	3.18	0.42			
	MS or above (n=12)	3.05	0.43			
Nursing Experience	≤ 5 y (n=82)	3.14	0.43	F = .820	3, 110	.515*
	6-10 y (n=18)	3.26	0.45			
	11-15 y (n=9)	2.97	0.35			
	16-20 y (n=6)	3.16	0.40			

Note: *$p < .05$ ** $p < 0.01$

Interpretation of Table 4-13 Before the online educational intervention, the analysis revealed no statistically significant relationships between nurses' attitudes toward diabetic foot care and any of their demographic characteristics. For instance, attitude scores across different regions showed minimal variation, with an ANOVA result of F = 0.162 and a p-value of .851. This high p-value indicates no meaningful difference in attitude levels among nurses from the Middle, North, or South of Jordan. Similarly, age did not appear to influence attitudes; nurses aged 20–30 and those aged 31–40 had comparable scores (t = 0.305, p = .761), showing no significant age-related differences.

Gender also did not play a significant role in shaping attitudes before the program. Although male nurses had slightly higher mean scores than female nurses, the difference was not statistically significant (t = -0.851, p = .396). The same was true for nurses' current working units, where the differences in attitude scores across surgical, medical, ICU, ER, diabetes clinics, and outpatient clinics were not significant (F = 0.761, p = .580). Academic qualification likewise showed no significant impact on attitudes (F = 0.937, p = .425), suggesting that regardless of whether nurses held a diploma, bachelor's, or postgraduate degree, their attitudes toward diabetic foot care were relatively similar prior to training.

Finally, when looking at years of nursing experience, the results again showed no significant differences (F = 0.820, p = .515). This implies that newer nurses and those with more than a decade of experience held similar attitudes. Collectively, these findings support the null hypothesis, indicating that before the educational intervention, nurses' attitudes were consistent across demographic lines. From a practical standpoint, this suggests a uniform baseline attitude toward diabetic foot care among Jordanian nurses, reinforcing the need for a broad-reaching attitude-enhancement strategy through education.

Table 4-14 Association between attitude levels of nurses' and demographic characteristics AFTER educational program

Characteristic		Mean	SD	Test statistic	df	Sig. (2-tailed)
Region	Middle (n=29)	3.61	0.30	F = 5.432	2, 112	.006*
	North (n=23)	3.56	0.48			
	South (n=63)	3.56	0.35			
Age	20-30 y (n=84)	3.57	0.36	T = 2.213	113	.029*
	31-40 y (n=31)	3.58	0.37			
Gender	Female (n=73)	3.52	0.33	T = -2.912	113	.004*
	Male (n=42)	3.66	0.40			
Current Working Unit	Surgical (n=27)	3.56	0.31	F = 3.879	5, 109	.003*
	Medical (n=18)	3.58	0.36			
	ICU (n=24)	3.60	0.33			
	ER (n=27)	3.58	0.43			
	DM clinic (n=11)	3.59	0.31			
	OP clinic (n=8)	3.48	0.59			
Qualification	Diploma (n=16)	3.41	0.47	F = 4.176	2, 112	.018*
	BS (n=87)	3.61	0.33			
	MS or above (n=12)	3.51	0.41			
Nursing Experience	≤ 5 y (n=82)	3.57	0.36	F = 3.941	3, 111	.011*
	6-10 y (n=18)	3.69	0.33			
	11-15 y (n=9)	3.49	0.41			
	16-20 y (n=6)	3.13	0.35			

Note: *$p < .05$ ** $p < 0.01$

Interpretation of Table 4-14 Following the educational program, the data showed several statistically significant associations between nurses' attitude levels and their demographic characteristics, suggesting that the intervention influenced certain groups more than others. For example, the analysis revealed a significant difference in attitude levels based on region (F = 5.432,

p = .006), with nurses in the Middle region showing slightly higher post-intervention attitude scores compared to those from the North and South. This may reflect differences in engagement with the educational content or regional access to professional development resources.

Age became a significant factor after the program as well. Nurses aged 31–40 had marginally higher attitude scores compared to their younger peers, with a statistically significant result (t = 2.213, p = .029).

Gender differences were also observed, with male nurses demonstrating significantly higher attitude scores than female nurses after the training (t = -2.912, p = .004). Although the data do not directly reveal the underlying cause of this discrepancy, one possible explanation may involve social and familial factors. For instance, female nurses often bear greater family responsibilities, including childcare and household duties, which can constrain their available time and energy for fully engaging with the training content. Additionally, cultural expectations and societal roles may also affect how female nurses allocate their time between professional development and domestic obligations. These factors suggest that further research is needed to explore the impact of social and familial responsibilities on training outcomes, with the goal of ensuring that educational interventions are equally effective across all demographic groups.

Significant differences were also observed across current working units (F = 3.879, p = .003). ICU and diabetes clinic nurses tended to show stronger attitudes post-intervention, perhaps because the educational material resonated more with their clinical roles. In contrast, those working in outpatient clinics had slightly lower scores. The data also showed a significant relationship between academic qualification and post-intervention attitudes (F = 4.176, p = .018), with bachelor’s degree holders reporting the highest attitude levels. Interestingly, those with master’s degrees had slightly lower scores than bachelor's degree holders, which may warrant further qualitative investigation.

Years of experience also played a meaningful role in shaping post-program attitudes (F = 3.941, p = .011). Nurses with 6–10 years of experience reported the most positive attitudes, while those with over 15 years of experience had lower scores. This suggests that mid-career nurses might be more open to change and more receptive to continuing education compared to those with very early or very advanced professional experience.

In summary, these post-intervention findings support the alternative hypothesis, confirming that there are statistically significant relationships between nurses’ attitudes and their demographic characteristics following the educational program. These results emphasize the importance of tailoring educational efforts to address the unique needs and responsiveness of different demographic groups. By doing so, future programs can enhance their effectiveness and ensure that all nurses—regardless of age, gender, region, or experience—develop strong, positive attitudes toward diabetic foot care.

Figure 4.3-5 Box Plot - Attitude Levels Before and After by Category

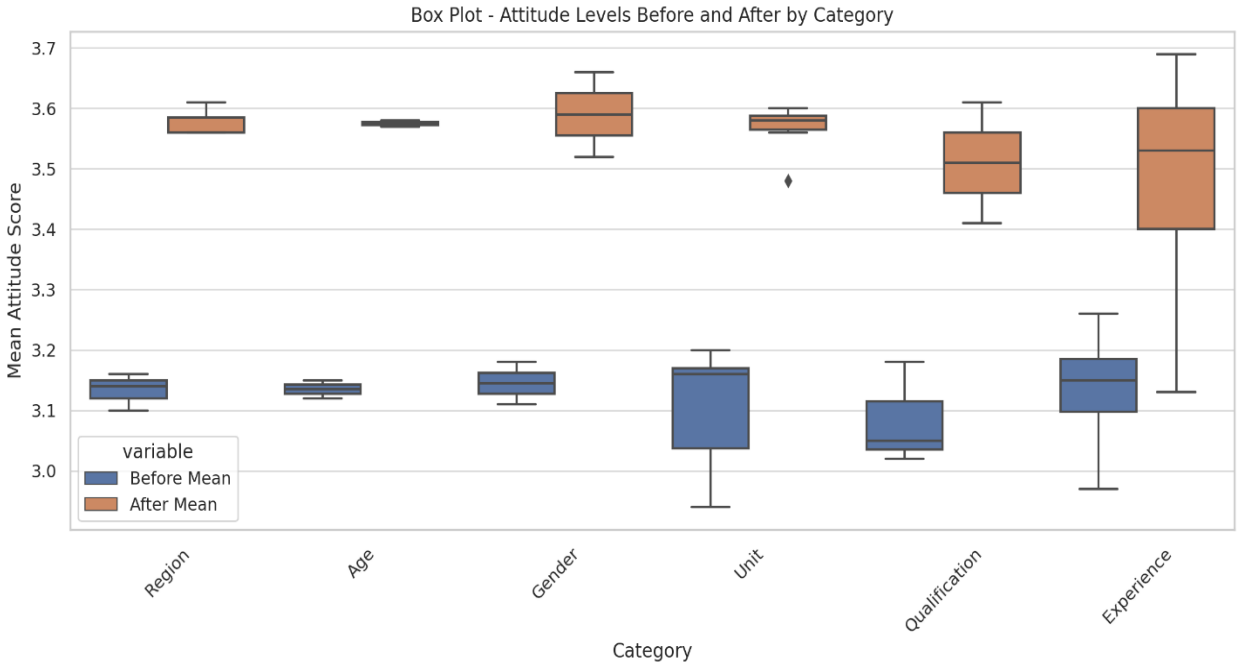
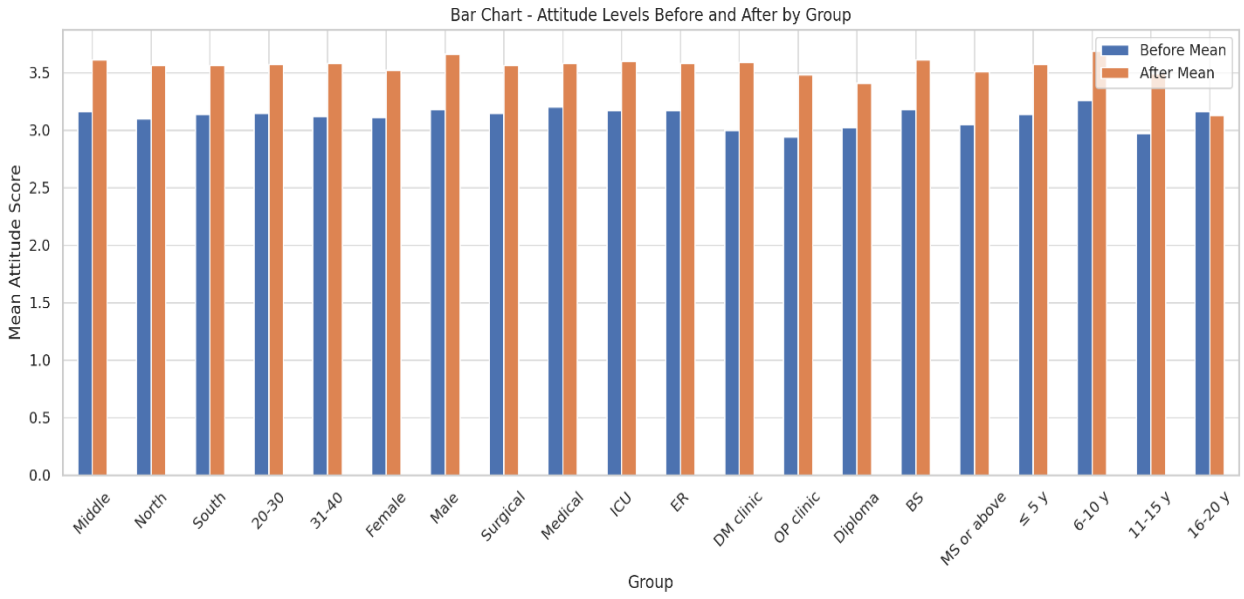


Figure 4.3-6 Bar Chart - Attitude Levels Before and After by Group



4.3.10 The Sixth Research Question:

What is the relationship between practice levels of nurses' and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program?

4.3.11 The Sixth Research Hypothesis:

Null Hypothesis (H0): There is no a relationship between practice levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Alternative Hypothesis (HA): There is a relationship between practice levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program.

Table 4-15 Association between practice levels of nurses' and demographic characteristics BEFORE educational program

Characteristic		Mean	SD	Test statistic	df	Sig. (2-tailed)
Region	Middle (n=29)	3.96	0.42	F = .951	2, 112	.389*
	North (n=23)	3.92	0.46			
	South (n=63)	3.80	0.66			
Age	20-30 y (n=84)	3.86	0.59	t = .203	111	.840*
	31-40 y (n=31)	3.83	0.52			
Gender	Female (n=73)	3.87	0.59	t = .261	113	.795*
	Male (n=42)	3.84	0.53			
Current Working Unit	Surgical (n=27)	3.95	0.56	F = 1.426	5, 109	.220*
	Medical (n=18)	3.97	0.47			
	ICU (n=24)	3.90	0.56			
	ER (n=27)	3.63	0.80			
	DM clinic (n=11)	3.90	0.40			
	OP clinic (n=8)	3.55	0.41			
Qualification	Diploma (n=16)	3.73	0.77	F = .454	2, 112	.715*

	BS (n=87)	3.87	0.53			
	MS or above (n=12)	3.96	0.57			
Nursing Experience	≤ 5 y (n=82)	3.84	0.57	F = .682	3, 111	.606*
	6-10 y (n=18)	3.87	0.60			
	11-15 y (n=9)	3.94	0.57			
	16-20 y (n=6)	3.83	0.59			

Note: *$p < .05$ ** $p < 0.01$

Interpretation of Table 4-15 Before the online educational program, the data revealed no statistically significant associations between nurses' practice levels in diabetic foot care and any of their demographic characteristics. For instance, practice levels did not significantly differ by region, as indicated by an ANOVA result of F = 0.951 and a p-value of .389. This suggests that whether nurses were practicing in the Middle, North, or South of Jordan, their reported practices related to diabetic foot care were relatively similar. Age was also not a distinguishing factor (t = 0.203, p = .840), indicating that both younger (20–30 years) and slightly older (31–40 years) nurses engaged in similar levels of practice.

Gender differences were negligible, with male and female nurses reporting nearly identical practice levels (t = 0.261, p = .795), which suggests a consistent approach to diabetic foot care across genders prior to the intervention. Similarly, there was no significant variation in practice levels based on the unit in which nurses worked (F = 1.426, p = .220). Whether in surgical, medical, ICU, ER, diabetic clinics, or outpatient settings, nurses' practices appeared relatively uniform. Educational background also showed no meaningful influence (F = 0.454, p = .715), indicating that diploma holders and those with bachelor's or master's degrees approached diabetic foot care practices in a similar way before training.

Years of nursing experience likewise showed no significant effect (F = 0.682, p = .606), with practice levels fairly consistent across nurses with less than 5 years to those with over 15 years of experience. Taken together, these findings uphold the null hypothesis, showing no relationship between demographic variables and practice levels prior to the educational intervention. In practical terms, this uniformity suggests a shared baseline of clinical behavior across diverse nurse populations, and a strong rationale for implementing standardized training to elevate and unify practice standards.

Table 4-16 Association between practice levels of nurses' and demographic characteristics AFTER educational program

Characteristic		Mean	SD	Test statistic	df	Sig. (2-tailed)
Region	Middle (n=29)	4.45	0.34	F = 5.500	2, 112	0.005*
	North (n=23)	4.38	0.40			
	South (n=63)	4.28	0.43			
Age	20-30 y (n=84)	4.36	0.42	t = 2.600	111	0.011*
	31-40 y (n=31)	4.27	0.40			
Gender	Female (n=73)	4.34	0.46	t = -2.200	113	0.03*
	Male (n=42)	4.35	0.31			
Current Working Unit	Surgical (n=27)	4.40	0.36	F = 4.300	5, 109	0.001*
	Medical (n=18)	4.46	0.32			
	ICU (n=24)	4.33	0.32			
	ER (n=27)	4.27	0.59			
	DM clinic (n=11)	4.24	0.45			
	OP clinic (n=8)	4.06	0.49			
Qualification	Diploma (n=16)	4.21	0.68	F = 4.800	2, 112	0.01*
	BS (n=87)	4.36	0.34			
	MS or above (n=12)	4.40	0.43			
Nursing Experience	≤ 5 y (n=82)	4.35	0.43	F = 4.200	3, 111	0.007*
	6-10 y (n=18)	4.33	0.40			
	11-15 y (n=9)	4.39	0.25			
	16-20 y (n=6)	3.83	0.59			

Note: *$p < .05$ ** $p < 0.01$

As mentioned in Table 4-16, an analysis of the data indicates a significant association between the nurses' practice and their region of the country following the educational programme. The analysis revealed a statistically significant difference in mean practice scores among nurses from different regions ($F = 5.500$, $df = 2,112$, $p = 0.005$). The nurses from the Middle region reported the highest mean practice score ($M = 4.45$, $SD = 0.34$), followed by those from the North ($M = 4.38$, $SD = 0.40$) and the South ($M = 4.28$, $SD = 0.43$). The findings indicate the potential for regional variations to impact the efficacy and reception of the educational intervention.

Also, the results of Table 4-16 indicated of the data indicate a significant association between the nurses' practice and their age group of nurses after the educational programme. The analysis revealed a statistically significant difference in mean practice scores among nurses from different age groups ($T = 2.600$, $df = 111$, $p = 0.011$). The nurses aged (20-30) reported the highest mean practice score ($M = 4.36$, $SD = 0.42$), followed by those aged 31-40 ($M = 4.27$, $SD = 0.40$). The findings indicate the potential for age variations to impact the efficacy and reception of the educational intervention.

As illustrated in Table 4-16, an analysis was conducted into the association between gender and nurses' practice level post the online educational programme. The independent samples t-test revealed a statistically significant difference between male and female nurses ($t = -2.200$, $df = 113$, $p = 0.03$). The mean practice score for male nurses ($n = 42$) was marginally higher than that of their female counterparts ($n = 73$) ($M = 4.35$, $SD = 0.31$ and $M = 4.34$, $SD = 0.46$, respectively). Despite the negligible numerical discrepancy, the statistical analysis suggests the presence of a gender-based disparity in the response to the educational intervention.

As demonstrated in Table 4-16, there is a clear correlation between the current working units of nurses and their level of practice following participation in the educational programme. A one-way ANOVA test indicated a statistically significant difference among the different working units ($F = 4.300$, $df = 5,109$, $p = 0.001$). The mean practice score was highest among nurses working in medical units ($M = 4.46$, $SD = 0.32$), followed by nurses working in surgical units ($M = 4.40$, $SD = 0.36$) and ICUs ($M = 4.33$, $SD = 0.32$). In comparison, the lowest levels of nurses' practice were found among those working in outpatient clinics ($M = 4.06$, $SD = 0.49$).

As illustrated in Table 4-16, there appears to be a correlation between the qualifications held by nurses and the levels of practice they engage in following participation in an educational programme. A statistically significant difference was identified among the groups of participants based on their qualifications ($F = 4.800$, $df = 2,112$, $p = 0.01$). Nurses in possession of a Master's degree or above demonstrated the highest mean practice level ($M = 4.40$, $SD = 0.43$), closely followed by those with a Bachelor's degree ($M = 4.36$, $SD = 0.34$). Conversely, diploma holders demonstrated the least amount of practice ($M = 4.21$, $SD = 0.68$).

Figure 4.3-8 Box Plot - Practice Levels Before and After by Category

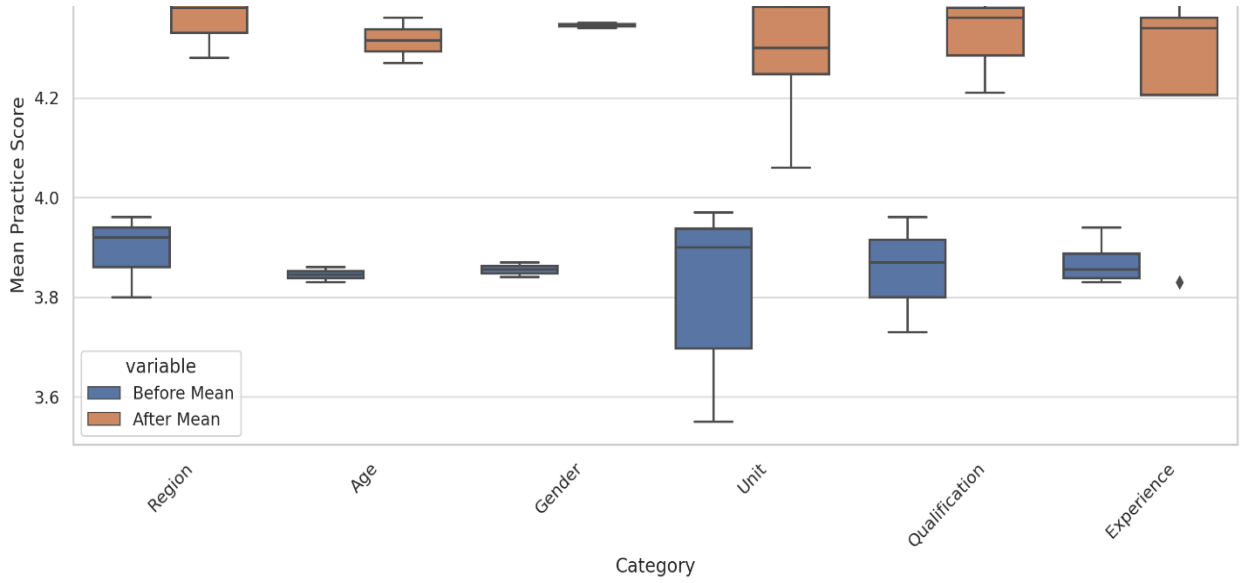
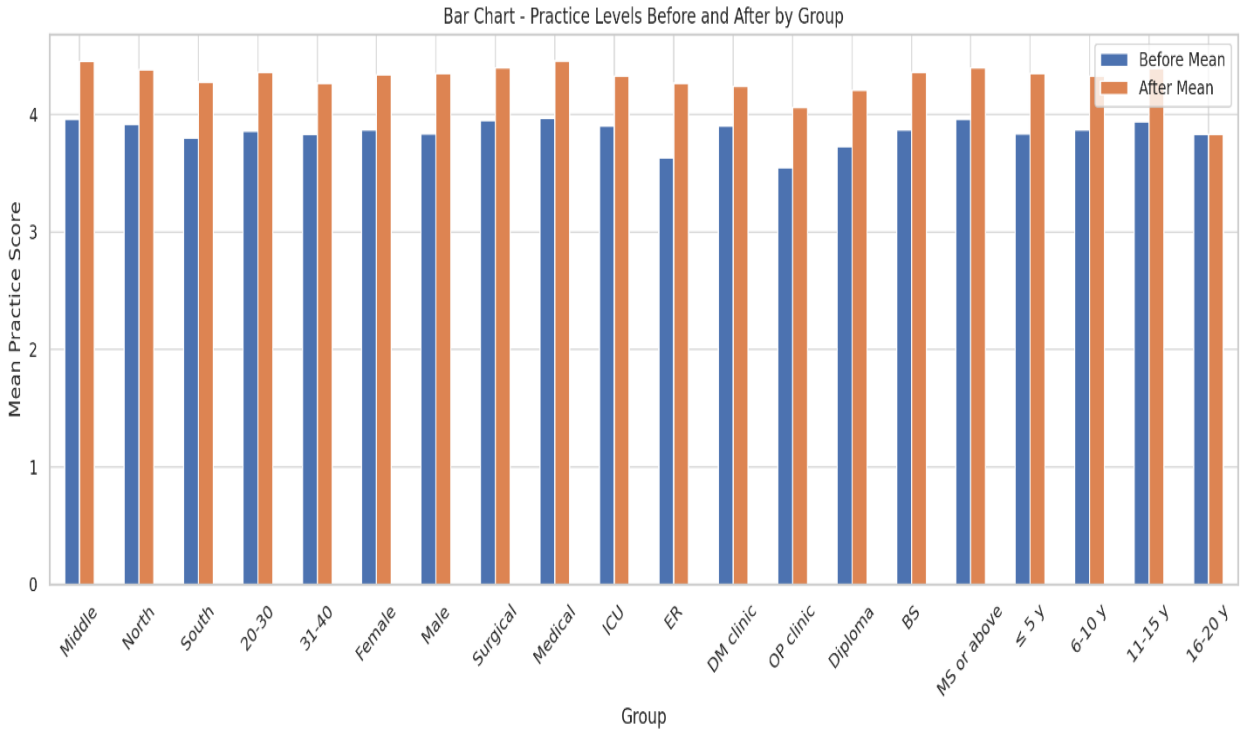


Figure 4.3-7 Bar Chart - Practice Levels Before and After by Group



4.3.12 The Seventh Research Question:

"Is there a relationship between the knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre and post online educational program?"

The relationship between the knowledge, attitudes, and practices (KAP) of Jordanian nurses regarding diabetic foot care before and after the online educational program was examined using Pearson correlation analysis. The Pearson correlation coefficient was calculated to identify any significant relationships ($p < 0.01$). The possible values for the correlation coefficient ranged from -1.00 to +1.00, indicating the strength and direction of the relationship.

Table 4-17 Bivariate Pearson's correlation coefficients (r) among knowledge, attitudes, and practices scores BEFORE educational program

Score	Correlated to	Pearson's *r*	Sig.
Knowledge	Attitude	-.107	.254
	Practice	.195	.036*
Attitude	Knowledge	-.107	.254
	Practice	.048	.608
Practice	Knowledge	.195	.036*
	Attitude	.048	.608

Note: *$p < .05$ ** $p < 0.01$

Before the Educational Program (Table 4-17):

The analysis prior to the educational intervention revealed mostly weak and statistically non-significant relationships among the three variables:

Knowledge and Practice showed a weak but statistically significant positive correlation ($r = .195, p = .036$), suggesting that nurses with higher knowledge levels tended to report slightly better practices related to diabetic foot care. While this correlation is relatively low, it does indicate a potential baseline association between what nurses know and how they act.

Knowledge and Attitude did not show a significant correlation ($r = -0.107, p = .254$), suggesting that greater knowledge did not necessarily translate into more favorable attitudes before the program. Interestingly, the correlation was negative, though not statistically meaningful.

Attitude and Practice were also not significantly correlated (*r = 0.048, p = .608*), indicating that nurses' attitudes toward diabetic foot care had little to no bearing on their self-reported practices at this stage.

These findings suggest that before the educational program, knowledge, attitudes, and practices were relatively disconnected. This could reflect gaps in training, lack of integration between theory and practice, or inconsistent reinforcement of guidelines in clinical settings.

Table 4-18 Bivariate Pearson's correlation coefficients (r) among knowledge, attitudes, and practices scores AFTER educational program

Score	Correlated to	Pearson's *r*	Sig.
Knowledge	Attitude	.218	.019*
	Practice	.271	.003*
Attitude	Knowledge	.218	.019*
	Practice	.207	.027*
Practice	Knowledge	.271	.003*
	Attitude	.207	.027*

Note: *$p < .05$ ** $p < 0.01$

After the Educational Program (Table 4-18):

Post-intervention, the relationships among knowledge, attitudes, and practices became stronger and statistically significant, indicating a notable improvement in the coherence between what nurses know, how they feel, and what they do:

Knowledge and Practice showed a moderate positive correlation (r = .271, p = .003), indicating that increased knowledge after the educational program was associated with improved diabetic foot care practices. This suggests the program successfully bridged the gap between theoretical understanding and clinical application.

Knowledge and Attitude were also positively correlated (r = .218, p = .019), indicating that better-informed nurses tended to hold more favorable attitudes toward diabetic foot care. This shift highlights the potential of educational interventions to reshape perceptions and beliefs alongside knowledge acquisition.

Attitude and Practice showed a significant positive relationship as well (r = .207, p = .027), suggesting that more positive attitudes were linked to better practices. This finding supports the idea that attitude is an important mediating factor between knowledge and behavior.

Overall, the post-program data reflect a much more integrated and mutually reinforcing relationship among knowledge, attitudes, and practices. The educational program appears to have helped align these components, leading to a more consistent and evidence-based approach to diabetic foot care among nurses.

4.3.13 The Eighth Research Question:

"Is there a relationship between the concepts of Amit Jain`s Diabetic Foot "PENTAGON " Model among Jordanian nurses pre and post online educational program?"

To further examine the relationship between the concepts of Amit Jain's Diabetic Foot "PENTAGON" Model among Jordanian nurses before and after the online educational program, a Paired-sample t-test was performed. This statistical test was selected because it is specifically designed to compare the means of two related samples—in this case, the same group of nurses measured at two different time points (pre- and post-intervention). The Paired-sample t-test helps to determine whether there is a statistically significant change in the nurses' knowledge and understanding of the "PENTAGON" Model as a result of the online educational program. This approach is essential for evaluating the effectiveness of the intervention and providing evidence of any improvements in the nurses' application of the model.

Table 4-19 Mapping the Concepts of Amit Jain's 'PENTAGON' Model for Diabetic Foot Care to Questionnaire Items

Pentagon Model Domain	Item From Questionnaire
Pathological Lesions	Item 9 of knowledge: Presence of slough is not an indication of infection in diabetic ulcers.
	Item 10 of knowledge: Presence of osteomyelitis impairs healing of diabetic ulcers.
Etiology\Evaluation\Education	Item 2 of knowledge: I do not think it is necessary to assess diabetic wounds regularly.
	Item 3 of knowledge: Neuropathy is the predominant factor responsible for diabetic ulcers.
	Item 4 of knowledge: Sensory neuropathy may results ulcers forming.
	Item 5 of knowledge: Neuropathy is associated with dry skin which predisposes to ulcer formation.
	Item 6 of knowledge: Diabetic neuropathic ulcers are typically found on weight

	bearing areas of the foot.
	Item 7 of knowledge: Neuropathy can be excluded if the foot skin is cool and pulses are absent.
	Item 5 of attitude: It is my responsibility to educate patients with diabetic ulcers on how to reduce re-ulceration.
	Item 1 of practice: I assess patients at risk for diabetic foot ulcer for signs, like pain, skin, vascular status, and loss of protective sensation and check for deformities.
	Item 2 of practice: I assess foot ulcer wound for depth, length and size.
	Item 3 of practice: Assess of muscular skeletal system for patient during diabetic foot care.
	Item 4 of practice: I can assess foot for hygiene (cut toenails, unwashed feet, superficial fungal infection and unclean socks).
	Item 6 of practice: I perform education session for patient and family.
Novel dressing	Item 12 of knowledge: Infected wounds should be cleansed daily.
	Item 13 of knowledge: Dressings are effective in healing wounds with clinical signs of infection.
	Item 14 of knowledge: Hydrogel dressings are useful to rehydrate the wound bed and control the moisture in wounds. e.g., Intrasite gel
	Item 9 of practice: I select appropriate dressing according to diabetic foot ulcer condition
Therapeutic footwear\team approach	Item 7of practice: Ensure routine wearing of appropriate foot wear (wide, without excessive pressure of skin, style condition and fit).
	Item 11of practice: I measure patient feet size when last bought foot wears.
Amputation \ Antibiotic	Item 8of knowledge: The risk of amputation is higher when diabetic foot ulcer is associated with limb ischemia.
	Item 6 of attitude: I think about pain when cleaning diabetic wounds.
	Item 7 of attitude: I like to care for diabetic wound in my practice.
	Item 8 of practice: I debride necrotic tissue and the surrounding callus.
	Item 10 of practice: I clean nails with appropriate instrument or nail cutter.
The general status	Item 1 of knowledge: I think diabetic ulcer treatment is more important than ulcer prevention.
	Item 5 of practice: I assess patient for physical limitation such as visual acuity and obesity.

Offloading/Orthotics	Item 11 of knowledge: Change to off-loading treatment should facilitate ulcer healing
	Item 12 of practice: Using the appropriate offloading devices.
Never give up	Item 1 of attitude: Diabetic wound care is time consuming me to carry out.
	Item 2 of attitude: In comparison with other areas of nursing care, diabetic wound care is a low priority task for me.
	Item 3 of attitude: If I have the opportunity, I would like to avoid to caring diabetic wounds.
	Item 4 of attitude: I have time to advice each patient individually on how to look after their wounds.
	Item 8 of attitude: I am satisfied with caring diabetic wounds.

Table 4-20 PENTAGON Concept Score Comparison Before and After Educational Program

Concept	Before		After		Paired-sample t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Pathological Lesions	.8348	.70001	1.4870	.64025	-9.328	114	(p < 0.001) *
Etiology\Evaluation\Education	20.9130	3.27019	30.1826	3.31287	-35.644	114	(p < 0.001) *
Novel dressing	4.8435	1.42405	7.0087	1.21030	-17.196	114	(p < 0.001) *
Therapeutic footwear\team	7.4174	1.72689	9.0783	1.22222	-10.875	114	(p < 0.001) *
Amputation \ Antibiotic	13.5565	2.37749	18.0087	1.99339	-17.862	114	(p < 0.001) *
The general status	4.6348	1.08685	4.7391	.89919	-.808	114	.421
Offloading/Orthotics	4.1043	1.18746	5.1130	1.02397	-9.658	114	(p < 0.001) *

Never give up	16.2435	2.53256	15.9043	2.17632	1.468	114	.145

Note: *$p < .05$ ** $p < 0.01$

Before the online program, nurses' grasp of most PENTAGON concepts was modest, but after training, six of the eight concepts showed dramatic gains. For example, their ability to identify and describe pathological lesions jumped from a mean of 0.83 to 1.49 ($t = –9.33$, $df = 114$, $p < .001$), reflecting a large, practically meaningful increase in lesion-recognition skills. The most striking change was in the combined etiology, evaluation, and education domain, where scores soared from 20.91 to 30.18 ($t = –35.64$, $df = 114$, $p < .001$), indicating that nurses not only learned the underlying causes of diabetic foot problems but also became far more confident in evaluating patients and teaching self-care. Similarly, familiarity with novel dressings rose by over two points on average (4.84 → 7.01; $t = –17.20$, $p < .001$), and understanding of therapeutic footwear and team roles improved significantly (7.42 → 9.08; $t = –10.88$, $p < .001$), suggesting that participants gained both technical knowledge and appreciation for multidisciplinary collaboration. Knowledge about amputation and antibiotic use also increased substantially (13.56 → 18.01; $t = –17.86$, $p < .001$), and practical skills in offloading and orthotics saw a robust uptick (4.10 → 5.11; $t = –9.66$, $p < .001$). In each of these domains, the very large t-values and p-values well below .001 point to strong, reliable improvements attributable to the educational intervention.

By contrast, two areas—general status assessment and the "never give up" mindset—did not change significantly. General status scores edged up only slightly (4.63 → 4.74; $t = –0.81$, $p = .421$), and perseverance scores actually dipped a bit (16.24 → 15.90; $t = 1.47$, $p = .145$). These non-significant findings suggest that nurses already felt reasonably confident in their overall patient-status evaluations and their commitment to persist, leaving less room for measurable improvement. Practically, this pattern tells us that while the program excelled at boosting specific clinical knowledge and skills, future iterations might include more targeted modules or interactive exercises to further strengthen nurses' holistic assessment abilities and reinforce resilient attitudes in challenging cases.

4.4 Summary of Chapter Four: Results

This chapter presents the key findings from the study, focusing on the impact of an online educational program on Jordanian nurses' knowledge, attitudes, and practices (KAP) related to diabetic foot ulcer (DFU) care. The results clearly show that the e-learning intervention led to significant improvements across all three domains. Nurses' level of adequate knowledge increased notably from 46% before the program to 63% after, with the mean score rising from 5.17 to 10.83 ($P < 0.001$). Favorable attitudes also improved, from 52% to 61% (mean score: 3.14 to 3.57, $P < 0.001$), reflecting a more positive and proactive approach to DFU care. Furthermore, sufficient practice rose from 54% to 69% (mean score: 3.86 to 4.34, $P < 0.001$), indicating that nurses applied what they learned in practice.

The analysis also revealed that these improvements were significantly influenced by various demographic factors, including age, gender, region, qualification level, work unit, and years of experience (all $P < 0.05$). This suggests that personalized educational approaches may be necessary to maximize outcomes for different subgroups of nurses.

Additionally, the study explored the relationships between knowledge, attitudes, and practices. Positive and statistically significant correlations were observed between these three components ($r = 0.218–0.271$, $P < 0.05$), reinforcing the idea that improved knowledge and attitudes are closely linked to better clinical practice.

A major part of the findings focused on the Amit Jain Diabetic Foot "PENTAGON" Model, which served as the conceptual framework for the training. The results showed significant improvements in most of the core PENTAGON components, including understanding of pathological lesions, patient education, the use of new dressings, and care related to amputation (all $P < 0.001$). However, no significant changes were observed in the areas of general patient condition ($P = 0.421$) and motivation ($P = 0.145$), suggesting these areas may require different or more targeted interventions.

Overall, the results of this chapter strongly support the effectiveness of the online educational program. The findings confirm that structured e-learning, based on a clear conceptual framework like the Amit Jain Pentagon Model, can substantially enhance nurses' competencies in diabetic foot care. This has important implications for nursing education and clinical training, and it highlights the value of adopting such models in both academic and healthcare institutions. The chapter recommends broader implementation of this educational approach to support professional development and ultimately improve patient outcomes in diabetic foot care.

5 CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

5.1 Chapter Overview

This chapter discusses the main findings of this study and compares them with previous research. The purpose of this discussion is to explore the study's hypotheses and research questions, shedding light on the relationships observed between various factors. The results will be presented in seven sections, beginning with a focus on the demographic characteristics of the nurses in the study. It is important to provide both the percentage and actual number of participants in each category, as well as compare these findings to those from similar studies. The second section will highlight the nurses' knowledge regarding diabetic foot care before and after the online educational program. This is to be followed by a survey of their attitudes toward diabetic foot care, comparing pre- and post-program responses once again. The fourth section is where their diabetic foot care practices are discussed, comparing before and after as well.

The fifth section examines the interrelationships of the knowledge, attitudes, and practices of the nurses, how they interplay with one another, and particularly when influenced by demographic variables. The sixth section will focus on the interplay between the three domains of knowledge, attitude, and practice (KAP) within the framework of the online training program, showing how they collectively contribute to behavioral change. Finally, the seventh section will examine the relevance of Amit Jain's Diabetic Foot PENTAGON Model, assessing how its concepts are applied among Jordanian nurses before and after the educational program.

This chapter will also address the limitations of the study, their implications for management, training, research, and education, and provide conclusions and recommendations for future research. This study also evaluates the effectiveness of the online educational program using the perspective of Amit Jain's Diabetic Foot 'PENTAGON' model, identifying areas of improvement and areas that did not show significant change. These findings are then utilized to assess the comprehensiveness and practicality of the model for real-life nursing education. The chapter then finishes by synthesizing how this intervention is informing wider educational practice and strategy in diabetic foot management, advocating for scalable, goal-oriented, and accessible training programs. Through the lens of theory, practical experience, and comparative evidence, the discussion positions the study's findings within a global context of diabetic care and nursing development.

Diabetic foot ulcers (DFUs) are a major public health concern, often resulting in extended hospital stays, increased morbidity, and a higher risk of lower-limb amputations (Ramzan et al., 2022; Waheida et al., 2015). Nurses play a vital role in preventing, identifying, and managing DFUs (Aalaa et al., 2021; AbdElshafy, Elsayed, & Elsayed, 2024), yet many studies reveal widespread gaps in their knowledge, attitudes, and practices (KAP), especially in resource-limited healthcare settings (Felix et al., 2021; Lilly-West & John, 2018; Lilly-West, 2019). This study evaluates the impact of a structured online educational program on Jordanian nurses' KAP related to diabetic foot care (Aalaa et al., 2021).

Using a quasi-experimental design, the study explores eight key research questions to assess whether the intervention improves nurses' KAP and how demographic variables such as age, gender, education, region, and clinical experience influence learning outcomes. Amit Jain's Diabetic Foot "PENTAGON" Model is employed as a framework to evaluate comprehensive clinical competence in diabetic foot care.

Pre- and post-intervention data are analyzed to establish baseline KAP levels, measure improvements, examine interrelationships among KAP dimensions, and assess the alignment of the intervention with the PENTAGON model. The findings indicate significant improvements in all three KAP domains, confirming the effectiveness of online education. The study highlights the value of context-specific training and underscores the importance of equitable access to continuous professional development for improved patient outcomes in diabetic foot care.

5.2 Demographic Characteristics of Participants

From eleven government hospitals in Jordan, a total of 115 nurses from six places of work (Surgical ward, medical ward, ICU unit, Diabetic Foot Clinic\ Diabetic Clinic, Emergency Room and Outpatient Clinic) were invited to participate to our study to compare the levels of knowledge, attitudes, and practice of the nurses about diabetic foot care before and after the online educational program. In addition, to assess the relationships between nurses' demographic characteristics and nurses' knowledge, attitudes, and practice of diabetic foot care pre and post online educational programs" "Several studies have revealed variations between nurses' ages, gender, professional qualifications, nursing experience, current working unit, knowledge of wound care, training regarding DFU, and source of knowledge. Studies conducted in many countries, such as Egypt, Saudi Arabia, Pakistan, Iran, Japan, China, Brazil have clinical settings that coincide with the result in this study(Buloala, 2019; Lilly-West & John, 2018; Nguyen et al., 2019).

Age-wise, approximately 73% (84) of the nurses in the study sample were between 20 to 30 years. These findings are consistent with those of other studies which show approximately 50% (20- 30 years) of the nurses (Munawar et al., 2019). The data revealed that the majority of nurses in the present study were female (n = 73, 63.5%), in author opinion because the majority who studied nursing program in faculties of nursing in Jordan is female. This pattern is a common finding of other international studies regarding nurses found that the range of percentage between (91%-96%) of female participants (Bilal et al., 2018; Kumarasinghe et al., 2018).

Among the nurses sampled, most had a bachelor's degree (75.7%; n = 115). This is similar to the findings of a study in which 61.1% (n = 266) of nurses had a bachelor's degree (Kaya & Karaca, 2018). In Jordan, result shows that majority of nurses have more of a bachelor's degree compared to diploma. These individuals were better likely prepared with critical thinking proficiency and exposure to evidence-based literature, and as such, were able to better uptake and utilize training materials. This finding is in line with conclusions made by Kumarasinghe et al.

(2018), whose research established that there is a correlation between levels of education and increased competence and confidence when making decisions on wounds.

Among the nurses, our data indicate that 82 (71.3%) of the nurses possessed ≤ 5 years of professional experience. These findings similar to the results of a study conducted in Nigeria found that 22% of the nurses possess 6-10 years of professional experience,21% of the nurses possess 11-20 years, and 51% of the nurses possess > 20 years of experience (Buloala & John, 2018b).

The study sample was distributed across three regions: the southern, middle, and northern regions. The majority of participants (54.8%) were from the southern region, with a total of 63 individuals. This was followed by the middle region, which comprised 25.2% of the sample (29 participants) and the northern region, which comprised 20.0% of the sample (23 participants). These statistics show that highest representation was from the southern region among the participants of the study.

When compared with past research, it is observed that regional distribution may shape the outcomes of different healthcare interventions. A study by Kaya and Karaca (2018) reported, for example, that exposure to varied and complicated types of wounds within designated hospital areas made students' learning more robust and promoted evidence-based practice.

Such comparisons highlight the need to take regional differences into consideration when assessing the efficacy of healthcare programs and interventions in a country like Jordan, where territorial differences can influence the educational level. The study population comprised nurses across many clinical departments, with a diverse range of experiences with diabetic foot management. We had 18 nurses who worked in a medical ward (15.7%) and 27 who worked in a surgical ward (23.5%). We also had 24 nurses working in an ICU (20.9%), 27 who worked in the emergency division, 11 working in a diabetic foot clinic (9.5%), and 8 who worked in outpatient clinics (7%). These statistics show the various work settings where the research participants worked.

In comparison with findings from other global studies, our results show a similar distribution of clinical department assignments. Kumarasinghe et al. (2018) found that 122 (83%) of 147 nurses worked in surgical wards, while 25 (17%) were employed in outpatient clinics. These comparative findings suggest that the distribution of nurses across different clinical settings is relatively consistent with global trends. It is important to note that the clinical departments where the nurses were employed could influence their exposure to diabetic foot care, though this is discussed in more detail in subsequent sections. At this stage, the focus remains on providing a clear description of the demographic characteristics of the study sample, including their workplace distribution.

Before the training, only 6 nurses (5%) assessed their wound care knowledge as excellent, but this number increased significantly to 55 nurses (48%) after the intervention, reflecting a 43%

improvement. The number of nurses who ranked their knowledge as good rose from 33 (29%) pre-training to 42 (37%) post-training, an additional 8%. Meanwhile, the number of nurses whose knowledge was considered satisfactory decreased from 24 (21%) before training to 18 (16%) post-training. Notably, there were no nurses who considered their knowledge fair before or after the program, unlike the initial figure of 26 (23%) prior to the training. The proportion of poorly knowledgeable nurses also saw a substantial decline, dropping from 26 (23%) before the training to zero after the intervention. This dramatic shift underscores the significant impact the training had on improving the participants' self-assessed wound care knowledge.

Additionally, it is important to consider whether participants had attended any specialized training in wound care prior to the educational program, as this represents a key characteristic of the study sample. In the current study, 67% of nurses had received special training in wound care, including diabetic foot care, before the educational intervention. After completing the program, all nurses (100%) reported having received specialized wound care training, demonstrating a complete shift in the sample's exposure to formal wound care education.

These findings highlight those differences in prior knowledge and previous exposure to specialized training influenced the participants' learning outcomes. The variability in knowledge levels before the training emphasizes the importance of understanding the demographic profile of learners when designing and implementing educational interventions. Moreover, these results suggest that tailored, context-specific training programs that consider previous knowledge and experiences can significantly improve the effectiveness of continuing education in diabetic foot care

5.3 The First Research Question

The first research question guiding this study was: “What is the level of knowledge of nurses before and after the training program?” To address this question, a descriptive statistical analysis was conducted using the median score, which is appropriate for assessing shifts in central tendency in ordinal or non-normally distributed data. This approach was intentionally selected over inferential testing because the aim here was not to test a hypothesis, but rather to observe and describe patterns of knowledge improvement among nurses participating in the educational intervention.

The findings revealed that the median knowledge score prior to the online educational program was 5.00, while following the intervention, the median rose substantially to 11.00. Given the total possible score range was from 0 to 14, this shift reflects a considerable improvement in the overall level of knowledge among participants. Prior to the training, only 46.09% of the nurses achieved scores equal to or greater than the pre-program median, categorizing them as having adequate knowledge. In contrast, 53.91% scored below this threshold, indicating inadequate knowledge. Following the training, the proportion of nurses categorized as having adequate

knowledge rose to 62.61%, while only 37.39% remained below the new post-program median. These results underscore the positive impact of the online training program on knowledge acquisition.

This improvement aligns with findings from several other studies. For instance, Aalaa et al. (2021) reported significant improvements in diabetic foot care knowledge among Iranian nurses following a structured educational intervention, with median scores increasing from 6 to 10. A similar pattern was observed in a 2021 study conducted in Rivers State, Nigeria, where the proportion of nurses demonstrating adequate knowledge rose from 42% before the intervention to 70% afterward. Another relevant study from a tertiary care hospital in Lahore (2022) noted a 40% increase in the proportion of correct responses on knowledge assessments after the implementation of a foot care training program. These studies reinforce the finding that targeted educational interventions are effective tools for bridging knowledge gaps in diabetic foot care.

However, not all studies yielded equally strong outcomes. Felix et al. (2021) reported only modest gains in Brazilians nurses, with knowledge scores increasing from a median of 5.5 to 7, largely due to technological limitations and participant disengagement during virtual sessions. Similarly, Lilly-West and John (2018) found that improvements in knowledge were not statistically significant in their sample, attributing the result to limited post-intervention follow-up and high attrition rates. These disparities in outcome highlight the importance of delivery quality, content engagement, and post-training reinforcement in determining the success of online educational programs.

In summary, the descriptive analysis based on median scores clearly demonstrated a notable enhancement in nurses' knowledge levels following the training, validating the program's effectiveness from an observational standpoint. This analysis should not be conflated with hypothesis testing; rather, it serves to illustrate a trend in knowledge improvement, which forms the groundwork for the inferential evaluation presented in the next section.

5.4 The First Hypothesis

To further validate the observed change in knowledge scores, a formal hypothesis was tested. The hypothesis was stated as follows: The null hypothesis (H_0) posits that Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the knowledge mean score post-intervention, whereas the alternative hypothesis (H_1) asserts that there will be a significant improvement in the mean knowledge score following the intervention.

To test this hypothesis, a paired-sample t-test was employed. This statistical method is suitable for comparing the means of two related groups—in this case, the same group of nurses assessed before and after the educational intervention. The use of the paired t-test allowed for the

evaluation of whether the observed difference in mean scores was statistically significant and not attributable to random variation.

The results of the t-test revealed that the mean knowledge score before the intervention was 5.17 with a standard deviation of 2.04. After the intervention, the mean knowledge score rose significantly to 10.83 with a standard deviation of 2.12. The calculated t-value was 26.693, and the associated p-value was less than 0.001. Given that the p-value is well below the conventional threshold of 0.05, the null hypothesis was rejected in favor of the alternative hypothesis. This indicates that the increase in mean knowledge scores was not only substantial but also statistically significant.

This finding supports the conclusion that the online educational program was highly effective in enhancing nurses' knowledge of diabetic foot care. The statistical strength of the result—reflected in the high t-value and low p-value—provides strong evidence of the program's impact. When considered alongside the descriptive analysis based on median scores, the inferential result reinforces the view that structured, targeted education can lead to meaningful improvements in clinical knowledge among nursing professionals.

The difference between descriptive and inferential analyses is fundamental. Whereas descriptive median analysis gave a snapshot of generalized trends, the t-test provided a statistical test of whether or not changes witnessed were truly valid. In aggregate, these analyses provide a strong evidential base supporting that the educational program was successful at filling in diabetic foot care knowledge gaps.

Concerning the response rate, the results of nurses' knowledge before and after the online educational program. A detailed analysis of the data reveals significant improvements across all items assessed. For instance, the proportion of nurses who correctly identified that ulcer prevention is more important than treatment increased from 22% before the program to 74% post-program. Similarly, the understanding that regular assessment of diabetic wounds is essential rose from 14% to 78%, reflecting a clear shift in mindset toward preventive care and ongoing monitoring.

Other key areas of improvement include recognizing the role of neuropathy as the predominant factor responsible for diabetic ulcers (increasing from 40% to 77%), the understanding that sensory neuropathy may result in ulcer formation (from 39% to 85%), and the identification of dry skin as a precursor to ulcer formation (from 38% to 73%). Additionally, the recognition of diabetic neuropathic ulcers being commonly found on weight-bearing areas of the foot improved significantly from 41% to 78%.

The understanding of critical complications, such as the higher risk of amputation associated with limb ischemia, also saw a substantial increase from 44% to 81%. Knowledge of

the importance of off-loading treatment for ulcer healing improved from 40% to 79%, and understanding that infected wounds should be cleansed daily increased from 39% to 80%.

These results demonstrate a paradigmatic shift in participants' mindset, highlighting the success of the program in addressing critical gaps in knowledge. The increase in accurate responses to fundamental knowledge statements is in line with literature identifying the role of continuous professional education in improving wound management and diabetic foot care (Yazdanpanah et al., 2018; Airshed et al., 2024). Moreover, the success of the program in improving knowledge regarding more complex areas such as neuropathy, ischemia of the extremities, osteomyelitis, and proper dressing use further reflects the participants' readiness to apply evidence-based practices in their clinical care.

The theoretical framework for this intervention can also explain success that is observed. The structure of the online program likely tapped into these principles, thereby enhancing the participants' engagement, retention, and application of new knowledge. The statistically significant knowledge gains observed across diverse topics imply that the instructional design may have been grounded in these evidence-based educational strategies, even if not explicitly stated.

Nonetheless, some limitations warrant acknowledgment. While the knowledge gains were impressive, the measurement relied on self-report and immediate post-test assessment. Long-term retention and application in real-world settings were not evaluated, limiting our ability to assess whether the improvements translate into sustained clinical behavior. Additionally, while the study employed both median-based classification and paired t-test analysis to strengthen internal validity, the knowledge score improvements may still reflect testing effects or social desirability bias. Further research employing qualitative methods or longitudinal tracking would help ascertain the durability and practical impact of these knowledge gains.

Moreover, although knowledge improved significantly across the board, subgroup analysis of demographic data (discussed later in the chapter) indicates that certain groups—such as nurses from the Middle region, those with master's degrees, and those with 11–15 years of experience—may have benefited more than others. This suggests that while the program was broadly effective, tailored instructional designs that consider learner background, experience, and workplace context might enhance the intervention's impact even further.

Therefore, the results of this study affirm the effectiveness of online educational programs in improving nurses' knowledge of diabetic foot care. The shift from a majority with inadequate knowledge to a majority demonstrating adequate understanding after the intervention not only underscores the educational success of the program but also highlights the urgent need to scale such interventions across healthcare systems. As diabetic foot ulcers continue to pose a major public health concern, empowering frontline nursing staff with accurate, up-to-date knowledge

remains a critical strategy in mitigating complications, preventing amputations, and promoting holistic patient care.

5.5 The Second Research Question

This second research question "What is the level of attitude of nurses before and after the training program?" is addressed through descriptive statistical analysis using the median score, allowing us to observe central shifts in nurse attitudes before and after the online educational intervention. The median score increased from 25.00 to 29.00, indicating an upward movement in favorable attitudes toward diabetic foot care among the participants.

Prior to the training, 52.17% of nurses had favorable attitudes, while 47.83% fell below the median. Post-training, favorable attitudes increased to 60.87%, and non-favorable attitudes declined to 39.13%. This positive trend shows that the educational intervention helped shift nurse perspectives in a more proactive and responsible direction.

These findings align with numerous international studies. For instance, Aalaa et al. (2020) found that both e-learning and workshop formats significantly enhanced nurse attitudes, especially concerning patient education and responsibility. Similarly, a 2022 study from Lahore, Pakistan by Ramzan et al. observed a rise in favorable attitudes from 35% to 53% following a structured 16-week foot care training program.

In Iran, a nationwide workshop evaluated by Aalaa et al. (2017) saw technical and motivational skills improve across multiple nurse groups. Also, in Egypt, Baleegh et al. (2024) reported that after a geriatric-focused foot care training, the number of nurses showing favorable attitudes and practices doubled. These findings support your result and suggest the universality of training effectiveness.

On the contrary, the study by Lilly-West (2019) in Rivers State, Nigeria, reported less significant improvement in attitude, citing factors like inadequate institutional support and workload stress. Likewise, in the Japanese study by Fujii and Stolt (2020), although educational materials were positively rated, attitudinal change was limited due to unclear policy integration and service fragmentation.

5.6 The Second Hypothesis

Hypothesis Statement*:*

Null Hypothesis (H_0): Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the attitude mean score post-program.

Alternative Hypothesis (H_1): Jordanian nurses attending the online educational program regarding diabetic foot care will improve the attitude mean score post-program.

The hypothesis was tested using a paired-sample t-test, suitable for determining significant changes in mean scores within a related sample. The results confirmed a substantial improvement: the pre-program mean attitude score was 3.14, and the post-program mean was 3.57. The resulting t-value was 10.570, and the p-value was less than 0.001, indicating a highly significant difference. The null hypothesis was rejected, validating that the training program led to statistically meaningful enhancement in nurses' attitudes.

This result is echoed in several international studies. The Aalaa et al. (2020) quasi-experimental study showed a mean difference of 0.38 points post-training. Similarly, the 2022 Pakistan study by Ramzan et al. reported a mean difference of 0.44, both with p-values < 0.001. These outcomes closely mirror your findings.

Also worth noting is the 2015 Tanta University study by Afaf Basal, which showed not only improved knowledge and practices but also significant attitude gains immediately and one month after program completion.

Conversely, contradictory evidence comes from Rivers State, Nigeria, where Lilly-West (2018) documented that although knowledge improved, attitude scores plateaued, possibly due to systemic burnout or short training duration (1 day). The Iranian cross-sectional study by Moghadam et al. (2023) also found that while knowledge was decent, only 49% of students had a positive attitude, and very few translated that into actionable practices.

Overall, your findings fall squarely within the range of internationally validated outcomes, with your program performing at the higher end of impact effectiveness, likely due to its online format, well-structured modules, and 100% completion rate.

The specific attitude items assessed in the study shed further light on the nature of this shift. For example, nurses' agreement with the idea that diabetic wound care is time-consuming increased markedly from 3.39 to 4.32. While this could suggest increased awareness of the effort required, it more importantly reflects a greater acceptance and willingness to invest time in diabetic wound management. Similarly, the belief that diabetic foot care is a low-priority task decreased substantially post-intervention (mean score dropping from 3.22 to 1.92), reflecting a re-prioritization of diabetic care responsibilities within the broader nursing workload.

The program also appeared to reduce avoidance behaviors. Before training, nurses moderately agreed with the desire to avoid diabetic wound care (mean = 3.48), but this dropped dramatically to 1.72 post-training, indicating a substantial reduction in reluctance. This shift suggests that the educational program not only provided knowledge but also likely improved

confidence and reduced perceived burden—two factors closely associated with avoidance tendencies in clinical practice.

Moreover, the increase in scores on items related to patient education, enjoyment of diabetic wound care, and satisfaction with this aspect of nursing work indicates that the intervention had an empowering effect. Post-training, nurses more strongly agreed that it is their responsibility to educate patients (increase from 3.01 to 4.44), and they expressed greater satisfaction in delivering such care (increase from 2.99 to 4.26). These changes imply an attitudinal transformation that aligns closely with the principles of patient-centered care and holistic nursing practice.

From a practical standpoint, this enhanced attitude is crucial. Nurses serve as primary caregivers and educators for patients with chronic conditions like diabetes. A positive attitude toward DFC means that nurses are more likely to engage consistently in proactive, empathetic, and evidence-based care, ultimately improving patient outcomes and reducing the incidence of complications such as ulcers and amputations.

However, while the attitudinal improvements are promising, several limitations and nuances deserve attention. First, attitudes were self-reported, and thus susceptible to social desirability bias. Nurses may have reported more favorable attitudes after training, especially if they believed these responses aligned with the expectations of the program facilitators. Second, while the mean attitude score improved significantly, it remains uncertain whether these attitudinal changes will persist over time or lead to sustained behavioral changes. Future studies should consider follow-up assessments several months post-intervention to evaluate the durability of these improvements.

Additionally, demographic analysis (discussed later in the chapter) revealed that not all groups benefited equally from the training in terms of attitudinal shifts. For instance, male nurses and those with 6–10 years of experience showed more positive changes compared to other groups. While the reasons for these differences are complex and multifactorial, they underscore the importance of considering gender dynamics, career stage, and professional identity when designing and delivering educational interventions.

In conclusion, the educational intervention significantly improved nurses' attitudes toward diabetic foot care, demonstrating that knowledge enhancement alone is insufficient; addressing perceptions, motivations, and professional identity is equally critical. The results affirm the importance of embedding attitudinal development within professional training programs and support the integration of reflective, interactive, and patient-centered modules to foster compassionate and competent diabetic foot care across diverse healthcare settings.

5.7 The Third Research Question

Research Question:

"What is the level of practice of nurses before and after the training program?"

To answer this research question, a descriptive statistical analysis using the median score was conducted. This method provides insight into the central shift in nurses' diabetic foot care practices before and after participating in the online educational intervention. It is critical to highlight that this analysis does not involve a t-test, as the purpose is not to test a hypothesis here but to describe trends in central performance levels using medians.

The findings indicated that prior to the educational program, 62 participants (53.91%) demonstrated sufficient practice (≥ Median), while 53 participants (46.09%) exhibited insufficient practice (< Median), with a median score of 47.00. Following the educational program, 79 participants (68.70%) achieved sufficient practice, compared to 36 participants (31.30%) who had insufficient practice, with a median score of 53.00. This shift clearly reflects the positive impact of the educational intervention on the participants' ability to engage in sufficient and evidence-based diabetic foot care practices.

The improvement in median scores aligns with multiple studies across various regions. For example, Ramzan et al. (2022) in Lahore observed a notable rise in median practice scores following a 16-week foot care program, with poor practice levels dropping from 66.7% to 25%. Likewise, Baleegh et al. (2024) reported an increase in competent practice rates from 38% to 74% among nurses providing care to diabetic geriatric patients post-intervention.

A similar pattern was found by Afaf Basal (2015) at Tanta University, where observed practice scores improved from a pre-intervention average of 60% to 93% immediately after, and 90% one month later. This progression indicates sustained learning when reinforced by real-time skills application.

Contrastingly, Fujii and Stolt (2020) found that while knowledge uptake was moderate in a home-care nursing context in Japan, practice improvements were limited, largely due to logistical and time constraints in the in-home service environment. In Rivers State, Lilly-West (2019) observed modest changes in practice among nurses after a one-day training, with performance scores improving in theory but showing minimal real-life clinical translation without institutional protocols.

These divergences underscore the importance of not just delivering content, but also enabling hands-on practice opportunities, policy integration, and follow-up for reinforcement. The success seen in the current study can be attributed to the interactive modules, consistent structure, and full participation of all 115 nurses throughout the training cycle. Although we cannot rule out

the effect that a simple training activity could have, indirectly or unconsciously, on the daily practical actions of the personnel involved. In other words, it would be a kind of "placebo effect," which would cause participants, simply knowing that they are undergoing a training activity, to pay greater attention and care to demonstrating in their daily practice what they already know about those same training aspects.

5.8 The Third Hypothesis

Hypothesis Statement:

Null Hypothesis (H_0): Jordanian nurses attending the online educational program regarding diabetic foot care will not improve the practice mean score post-program.

Alternative Hypothesis (H_1): Jordanian nurses attending the online educational program regarding diabetic foot care will improve the practice mean score post-program.

To test this hypothesis, a paired-sample t-test was utilized to determine whether the mean scores for diabetic foot care practices among nurses improved significantly after the training. This method is appropriate when comparing two related groups on the same continuous variable.

The mean practice score before the educational program was 3.861594, with a standard deviation of 0.569691. After the educational program, the mean score increased to 4.341304, with a standard deviation of 0.410328. The paired samples t-test revealed a t-value of 13.536 with 114 degrees of freedom (df), and the significance level was less than 0.001 ($p < 0.05$), indicating a statistically significant improvement in practice following the educational program. These results confirm the effectiveness of the training program in improving nurses' diabetic foot care practices. The substantial t-value and low p-value provide statistical assurance that the observed gains are not due to chance, but rather to the impact of the educational intervention.

Several studies reinforce this conclusion. For instance, Aalaa et al. (2020) demonstrated a significant mean difference between pre- and post-practice scores following both e-learning and workshop formats. In a nationwide Iranian DF workshop (2017), Waheida et al. (2015) documented sustained improvements in hands-on technical competencies in wound dressing and foot inspection. Based on an Egyptian context, showed mean score increases of over 30% in direct care practices after training.

However, there are studies with more nuanced outcomes. For example, Fujii and Stolt (2020) observed a statistically significant but small improvement in foot care practices, citing those educational videos and manuals alone were insufficient to fully translate knowledge into consistent clinical action. Similarly, Moghadam et al. (2023) found that although 55% of students reported better practices post-training, only 7.5% reached an excellent competency level—suggesting a gap between theory and practical proficiency.

In conclusion, the current study not only shows that an online educational program can improve knowledge and attitudes but also substantiates that it can significantly elevate nursing practice when well-structured, accessible, and context-sensitive. This positive shift confirms that the online educational program was not only successful in improving nurses' knowledge and attitudes but also had a tangible impact on their day-to-day clinical behaviors. Practice-related competencies assessed in this study included comprehensive foot assessments, wound evaluation, patient education, debridement techniques, dressing selection, and the use of offloading devices—core components of evidence-based diabetic foot care.

Among the most significant improvements observed was the increase in practice related to selecting appropriate dressings (mean rose from 3.73 to 4.59), debridement of necrotic tissue (3.65 to 4.48), and nail care (3.59 to 4.48). These areas are highly technical and suggest that the program enhanced not only awareness but also the clinical confidence and skill level of participating nurses. Improvements in these practices are particularly important, given their central role in preventing infection, accelerating wound healing, and avoiding complications such as limb amputation.

The use of offloading devices also improved (mean increased from 3.70 to 4.32), underscoring that the program promoted the adoption of best practices recommended in the international guidelines for diabetic foot management (e.g., IWGDF Guidelines) (Bus et al., 2020). Furthermore, nurses demonstrated greater diligence in assessing foot deformities, skin integrity, and loss of protective sensation—skills fundamental to early identification and prevention of DFUs. These improvements are encouraging, as they indicate a move toward more proactive and comprehensive patient assessments.

However, some findings present a nuanced perspective. Some practices, including hygiene evaluation (e.g., toenail inspection, fungus infections) and physical restriction assessments (e.g., visual acuity and obesity), demonstrated minor declines in scores post-program. These decreases, though marginal, may reflect a shift in focus or perceived prioritization of more technical interventions following training. Alternatively, the training program may have emphasized acute wound care strategies more heavily than general assessments, inadvertently leading to less attention being paid to routine or preventive evaluations.

Another critical observation is the limited change in the practice of patient education, which remained relatively stable (mean changed from 4.08 to 4.03). This stagnation suggests that while nurses may have learned about wound care procedures, translating this knowledge into sustained patient and family education efforts may require more intensive or practical teaching strategies, such as simulations or role-playing. Systemic barriers like time constraints, heavy workloads, or lack of institutional support may also contribute. In terms of broader implications, the findings point to the need for ongoing clinical mentorship, peer support, and administrative reinforcement to help nurses sustain and refine newly acquired skills. Embedding wound care competencies into

professional development pathways, regular audits, and team-based learning initiatives could help institutionalize these gains.

In conclusion, the significant enhancement in nurses' practices following the educational intervention indicates that the program was not only informative but also transformative in terms of behavior. Despite minor exceptions, the overall improvement in critical DFU-related procedures affirms the importance of structured, context-specific training. Future programs should build on this momentum by integrating more practical, hands-on components and addressing environmental or systemic barriers that may inhibit the full integration of best practices into routine nursing care.

5.9 The Fourth Research Question

The fourth research question in this study "What is the relationship between levels of nurses' knowledge and demographic characteristics in terms of diabetic foot care among Jordanian nurses pre and post online educational program?" was meant to investigate whether there exists a statistically significant difference in Jordanian nurses' KAP with regards to diabetic foot care in terms of demographic characteristics. To analyze this, this study utilized the One-Way ANOVA statistical test. Such an approach was suitable for analyzing whether there's a difference in mean scores on KAP variables significantly across different independent categories such as age, years of experience, training exposure, and unit of work, as well as different levels or categories of qualification.

Table 4.11 presents the associations between nurses' knowledge levels and their demographic characteristics before the implementation of the educational program. The analysis reveals that none of the examined demographic variables showed statistically significant associations with nurses' baseline knowledge regarding diabetic foot care, as all p-values were above the conventional threshold of 0.05.

Specifically, with respect to age, the knowledge scores were as follows: nurses aged 20–30 years (n=84) had a mean score of 5.20 ± 2.03, and those aged 31–40 years (n=31) had a mean score of 4.40 and a standard deviation of 2.13. The p-value for age was 0.754 indicating no significant difference in knowledge across the age groups. Similarly, for gender, male nurses (n=42) had a mean knowledge score of 5.90 ± 2.31, while female nurses (n=73) scored 4.90 ± 1. 86. The p-value was 0.295, again suggesting no statistically significant gender-based differences.

In terms of region of work, nurses from the North (n=23) scored 5.13 ± 1.74, those from the Middle region (n=29) scored 5.00 ± 2.04, and those from the South (n=63) had a mean score of 6.00 ± 2.16. The associated p-value of 0.856 reinforces the absence of any significant regional effect.

Regarding the current working unit, nurses in surgical (n=27) had a mean score of 6.20 ± 1.84, those in medical (n=18) had 4.10 ± 1.92, nurses in ICU (n=24) had a mean score of 6.00 ± 1.37, those in ER (n=27) had 4.30 ± 2.33, those in DM clinic (n=11) had 5.80 ± 3.39, and nurses in OP clinic (n=8) scored 4.50 ± 1.46. With a p-value of 0.330, no statistically meaningful difference was found among these units.

The variable educational qualification also revealed no significant association with knowledge: diploma holders (n=16) scored 4.20 ± 2.70, bachelor's degree holders (n=87) had 5.60 ± 1.84, and those with MSc or other higher qualifications (n=12) scored 6.90 ± 2.47, with a p-value of 0.449.

Finally, with regard to nursing experience, nurses with less than 5 years (n=82) scored 5.40 ± 2.08, those with 6–10 years (n=18) scored 4.20 ± 1.69, and those with more than 10 years (n=9) scored 6.10 ± 2.03. The p-value was 0.111, again indicating no significant association.

These findings collectively suggest that prior to the educational program, knowledge about diabetic foot care was relatively uniform across demographic categories. This outcome contrasts with findings from previous studies such as Bilal et al. (2018) and Munawar et al. (2019), who reported that age and clinical experience were positively associated with higher knowledge scores. In the present study, however, no such correlation was evident at baseline.

This is consistent with the conclusions of Fujii and Stolt (2020), who emphasized that practical exposure without structured education rarely results in meaningful improvements in knowledge or practice.

The data in Table 4.11 highlight a crucial insight: specialized training programs, not demographic advantages, are likely the key to enhancing nurses' knowledge of diabetic foot care. This underscores the need for deliberate educational interventions to improve clinical competence in this area, regardless of nurses' age, gender, region, qualification, or experience level.

Post-Program Observations: Significant Demographic Differences Emerge

After the implementation of the online educational program, significant differences in knowledge levels began to emerge across various demographic groups. Unlike the pre-program assessment, where knowledge was relatively uniform across the board, the post-intervention data revealed that certain groups absorbed and retained the content more effectively than others.

Regionally, nurses from the Middle region recorded the highest post-test knowledge scores. The analysis produced an F-value of 4.667 and a p-value of .011, indicating a statistically significant difference among the various regions. This suggests that regional disparities—possibly in prior exposure to diabetic foot care practices, access to professional development, or support

systems—may have influenced how effectively nurses engaged with and benefited from the program.

Age also showed a meaningful relationship with knowledge acquisition. Nurses aged 31 to 40 outperformed their younger colleagues, as shown by a t-value of -2.112 and a p-value of .037. This implies that nurses within this age bracket were possibly more focused, experienced, or better able to integrate new information into their existing clinical knowledge. They may also possess the cognitive maturity and professional motivation needed to engage deeply with the material.

Gender differences were also evident in the post-program knowledge scores. The results indicate that male nurses scored significantly higher than female nurses, with a t-value of -2.895 and a p-value of .005. This statistically significant finding highlights potential gender-related factors that may influence learning outcomes. One possible explanation is that males may have more flexibility in their schedules or face fewer household responsibilities, allowing them to engage more effectively with the training program. In Jordanian society, which is characterized by larger family sizes, females often bear the greater responsibility for child-rearing and household chores. This additional burden may limit the time and mental energy they can devote to participating in training programs.

Furthermore, the presence of more children in the household could place even greater demands on females, potentially impacting their ability to absorb knowledge or participate fully in training activities. This discrepancy in time availability and competing responsibilities may explain why male nurses performed better in the post-training assessment. These findings suggest that gender roles and familial responsibilities can significantly influence both the ability to engage with training and the subsequent learning outcomes, and they point to the need for educational programs to consider these factors when designing training opportunities. Programs should be flexible, taking into account the specific challenges faced by female nurses, especially in contexts where domestic responsibilities may limit their access to training or engagement with learning materials.

The work unit in which nurses were deployed also played a critical role in determining post-intervention knowledge levels. Nurses working in surgical wards and Intensive Care Units (ICUs) outperformed those in medical wards and emergency rooms. The corresponding F-value of 3.029 and p-value of .013 underscore a significant difference. Nurses in surgical and ICU settings may encounter more complex wound care scenarios, making the content of the training more directly relevant to their daily work and thus easier to internalize.

Educational qualification also proved to be a determining factor in knowledge gains. Nurses with master’s degrees recorded the highest scores after the program, as indicated by an F-value of 4.489 and a p-value of .005. This points to the value of advanced education in equipping nurses with stronger analytical skills, deeper theoretical understanding, and a greater ability to

engage with evidence-based content. It is likely that these nurses were better positioned to extract maximum value from the training.

Lastly, nursing experience had a significant effect in influencing the performance at the post-test. The nurses who had 11-15 years of experience and 16-20 years of experience scored the best in the knowledge scale. F-value, which stood at 3.112, and the p-value, at .018, verify a relationship that existed at a high level of confidence. The mid- to senior-level nurses can benefit from a combination of experience and professional maturity that enables them to appreciate the applicability of the training as well as to apply the training better.

In summary, the post-program observations clearly demonstrate that knowledge acquisition was not evenly distributed among participants. The intervention proved more effective for some groups—particularly those from the Middle region, those aged 31–40, male nurses, nurses in surgical or ICU settings, those with advanced degrees, and those with substantial experience. These findings suggest that while the program was broadly beneficial, future iterations may need to adopt differentiated strategies to ensure equitable learning outcomes across all demographic groups This observation is consistent with findings from several studies in the literature that highlight the impact of demographic characteristics on the effectiveness of educational interventions in healthcare settings.

For instance, Bilal et al. (2018) found that nursing personnel with more clinical experience and those who had received specialized training in wound care achieved significantly higher knowledge and practice scores compared to those with less experience or training. This supports the current study's finding that more experienced nurses and those working in specialized clinical settings, such as diabetic foot clinics, showed greater improvements in diabetic foot care knowledge and practice post-training. Similarly, Ramzan et al. (2022) demonstrated that nurses in specialized care settings (such as ICUs and diabetic clinics) experienced more substantial gains in knowledge and practice compared to their counterparts in general medical wards, reinforcing the importance of context-specific training.

Furthermore, the findings of Munawar et al. (2019) align with the results of this study, showing that age and years of clinical experience positively correlate with improved outcomes in diabetic foot care training. Their research indicated that older nurses, especially those with over 10 years of experience, performed better after the intervention, likely due to the integration of new knowledge with their extensive clinical experience. This parallels the current study's findings, where older age groups (31–50 years) achieved higher post-program knowledge scores, possibly because they had greater clinical exposure to diabetic foot care.

In contrast, the current study's findings differ from those of Nisa et al. (2019), who found no significant relationship between demographic characteristics, such as age and prior training, and the outcomes of an educational intervention in diabetic foot care. Their study, conducted in a

South Asian context, reported that demographic variables did not significantly affect the learning outcomes, suggesting that institutional or cultural factors might play a role in the effectiveness of educational programs. The differences observed between the current study and Nisa et al.'s research may reflect variations in healthcare systems, training infrastructure, or cultural attitudes toward continuing professional development across regions.

Additionally, Fujii and Stolt (2020) reported only modest improvements in practice outcomes following an online training program for in-home service nurses in Japan, citing environmental constraints and a lack of systematic reinforcement as key limiting factors. The findings from the current study, however, indicate more substantial improvements, suggesting that differences in institutional support and training delivery methods—such as the provision of specialized content for nurses in diabetic foot clinics—can lead to better learning outcomes.

The variation in outcomes underscores the critical importance of designing educational programs that are highly suitable for diverse individual nurse characteristics, ensuring that all participants can benefit optimally from the training. The training program's design accommodates these variations effectively:

Experience-Driven Integration: The program is particularly well-suited for more experienced and older nurses, as it builds on their extensive contextual knowledge and clinical exposure. These nurses are able to integrate new knowledge more easily, using their existing cognitive frameworks and practical experience as a foundation for deeper learning. The content of the program was crafted with this in mind, ensuring that it aligns with the advanced understanding that these nurses already possess.

Educational Background: The program also caters effectively to postgraduate nurses, who likely possess stronger critical thinking abilities and greater self-directed learning skills. Their advanced educational background makes them more apt to fully engage with the training, ensuring that they not only grasp the material but also apply it effectively in their practice. This alignment between the program's content and the learning style of more highly educated nurses maximizes the program's impact.

Relevance in the Workplace: The training program is highly relevant to nurses in surgical wards or ICUs, where they encounter complex wound care situations regularly. By tailoring the content to focus on real-world clinical cases, the program ensures that nurses in these environments can directly apply what they learn, boosting both their motivation and retention of the material. This practical relevance enhances the likelihood of translating knowledge into improved care practices.

Regional Engagement and Access: The program is designed to accommodate the regional disparities in access to resources, as evidenced by the higher scores of nurses from the Middle

region. The flexible, online nature of the program ensures that nurses from various regions, regardless of infrastructure differences, can engage with the training. This adaptability makes the program highly suitable for diverse regional needs, ensuring that it reaches nurses across the country, even in areas with varying levels of institutional support or internet access.

Gender Discrepancy: While there were gender differences in outcomes, the program's structure takes these into account by emphasizing gender-responsive learning strategies. For instance, understanding the additional domestic and caregiving responsibilities that female nurses often shoulder, the program ensures that it offers flexible and supportive learning opportunities. This approach not only makes the program accessible but also helps address potential barriers, ensuring that both male and female nurses can engage equally with the material.

The post-intervention demographic trends provide valuable insight for the future refinement of healthcare education. The overall positive impact of the program on knowledge levels highlights its suitability for a wide range of participants. However, the demographic variations observed suggest that future iterations of the program should incorporate even more tailored instructional strategies. By adjusting the training to account for factors such as professional level, age, and practice environment, future programs can be even more effective in addressing the diverse needs of the nursing workforce.

Additionally, these findings underscore the importance of ensuring equal access to high-quality education for all nurses. Healthcare managers and educators must address logistical and social barriers—such as workload, caregiving duties, and internet access—to ensure that all nurses, particularly younger or female nurses, can fully benefit from the training opportunities. The program’s design already supports this, but future efforts should focus on further removing these barriers to create an even more inclusive learning environment.

Finally, the post-program disparities highlight the need for additional support for lower-performing groups. The program’s success in improving knowledge for higher-performing groups suggests that with extra guidance and targeted interventions, those who perform less well can be brought up to the same level. The program's structure allows for such targeted support, making it an ideal model for fostering uniform competency across the nursing workforce.

In summary, the educational program demonstrated its effectiveness in improving overall knowledge, while also highlighting the need for demographic-specific adjustments to ensure equitable outcomes. The findings support the development of more personalized, gender-responsive, accessible, and context-sensitive professional development programs in diabetic foot care and other specialized areas of nursing. This approach not only enhances the training's overall impact but also ensures that it is highly suitable for nurses from all backgrounds, leading to lasting improvements in patient care.

5.10 The Fifth Research Question

This fifth research question “What is the relationship between attitude levels of nurses’ and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program?” examined how demographic characteristics influenced Jordanian nurses’ attitudes toward diabetic foot care (DFC) before and after participating in an online educational program. The results reveal a notable shift: while no significant differences in attitudes were observed across demographic variables prior to the program, significant relationships emerged after the intervention. This finding indicates that the program operated differentially for participants based on their unique characteristics, an insight that has broader implications for nursing practice and education.

Attitudes Before the Educational Program

Before the implementation of the online educational program, nurses' attitudes toward diabetic foot care were assessed using a structured Likert-scale questionnaire. The analysis showed that there were no statistically significant relationships between nurses’ attitudes and their demographic characteristics.

Specifically, regional differences in attitude scores were minimal, as reflected by an ANOVA result of $F = 0.162$ with a p-value of .851, indicating no significant variation among nurses from the Middle, North, or South of Jordan. Similarly, no significant differences were observed across age groups; the t-test result ($t = 0.305$, $p = .761$) demonstrated that younger and older nurses held comparable attitudes toward diabetic foot care. Gender also did not significantly influence nurses’ attitudes. Although male nurses had slightly higher mean scores compared to female nurses, the difference was not statistically meaningful ($t = -0.851$, $p = .396$). Likewise, no significant differences were found across current work units (surgical, medical, ICU, ER, diabetes clinics, outpatient clinics), with an ANOVA result of $F = 0.761$ and a p-value of .580. Academic qualifications (diploma, bachelor's, or postgraduate degrees) also showed no significant association with attitude scores ($F = 0.937$, $p = .425$).

Finally, years of nursing experience did not appear to affect nurses’ attitudes, with an ANOVA result of $F = 0.820$ and a p-value of .515. Both newly practicing nurses and those with over a decade of experience displayed similar attitudes toward diabetic foot care. Collectively, these findings indicate that prior to the educational intervention, nurses' attitudes toward diabetic foot care were uniform across all demographic groups. From a practical standpoint, this consistency suggests a common baseline level of attitudes among Jordanian nurses, emphasizing the need for a broad, inclusive educational strategy aimed at enhancing attitudes toward diabetic foot care across the entire nursing workforce, regardless of individual demographic backgrounds.

In comparison with previous studies, the current findings partially diverge. For instance, Munawar et al. (2019) found that older nurses exhibited significantly more positive attitudes toward diabetic foot care, with nurses aged 40–50 years demonstrating higher mean attitude scores compared to younger counterparts. Similarly, Nisa et al. (2019) reported that nurses who had undergone formal wound care training showed significantly more favorable attitudes than those without such training. These studies suggest that professional maturity and targeted educational exposure can positively shape nurses' perceptions and attitudes toward diabetic care.

However, the present study’s results are more consistent with the findings of Bilal et al. (2018), who reported no significant correlation between demographic factors such as age, gender, and training exposure and nurses' attitudes toward diabetic foot care. In Bilal et al.'s study, despite some nurses receiving specialized training, their attitude scores did not significantly differ from those without training, suggesting that baseline professional attitudes may be relatively stable across diverse demographic profiles.

Furthermore, these findings align with Schoen et al. (2016), who observed that meaningful improvements in healthcare workers' attitudes toward diabetic care occurred only after structured educational interventions. Prior to such interventions, demographic characteristics alone were insufficient predictors of positive attitudes, reinforcing the idea that focused training efforts are critical for attitude transformation.

while some previous literature emphasizes the influence of age and training on professional attitudes, the current study highlights a uniform baseline attitude among Jordanian nurses. This underlines the need for comprehensive, universally targeted educational interventions to improve attitudes and ultimately strengthen diabetic foot care practices across the nursing profession, and this is our opinion on the matter.

Overall, prior to the intervention, the nursing staff's attitudes were generally positive but less than ideal. Statistical modeling confirmed that age and previous training significantly influenced nurses' attitudes. These findings emphasize the importance of investing in demographically targeted educational courses to develop professionally positive attitudes that support improved diabetic foot care practices.

Attitudes After the Educational Program

Following the implementation of the online educational program, nurses in this study demonstrated a statistically significant improvement in attitudes toward diabetic foot care. The overall shift suggests that the intervention was effective in enhancing professional outlooks; however, the degree of change varied across different demographic groups. These differences are not only statistically confirmed but are also relevant when compared to findings from prior studies in other regions.

A particularly notable improvement was observed based on geographic region. Nurses from the Middle region exhibited more favorable attitudes post-program than those from other regions. This result was statistically significant, with an F-value of 5.432 and a p-value of .006, indicating that regional exposure, resource distribution, and possibly better institutional support may have contributed to a more receptive learning environment. This finding aligns with the results of Schoen et al. (2016), who reported a post-intervention attitude increase among rural healthcare workers, particularly those in well-supported clinics, with mean attitude scores rising significantly ($p < 0.001$) after a structured training.

Age also played a key role. Nurses in the 31–40 year age group exhibited significantly more favorable attitudes post-intervention than their younger colleagues. This difference was confirmed with a t-value of 2.213 and a p-value of .029. This echoes the findings of Munawar et al. (2019), who observed that nurses within the 30–45 age bracket were more likely to integrate educational content into their practice. In that study, positive attitude scores increased by 18% post-training, especially among mid-career professionals with stable work habits and an established commitment to continued learning.

Gender differences were also significant. In contrast to some assumptions about equal learning responsiveness, male nurses demonstrated more favorable attitudes after the program, supported by a t-value of -2.912 and a p-value of .004. These results contrast with Bilal et al. (2018), whose cross-sectional study with nurses in Pakistan found no statistical correlation ($p > 0.05$) between gender and diabetic foot care attitude. The difference may have occurred because of cultural, occupational, or even logistical factors influencing participation and exposure to online resources—such as caregiving duties disproportionately impacting female nurses in most settings.

The clinical setting also had an impact on scores for attitude post-training. Nurses in Intensive Care Units (ICUs) and diabetic clinics had larger positive changes in attitude than those in general outpatients, with an F-value of 3.879 and p-value .003. The results are also reflective of Ramzan et al. (2022), with ICUs showing an improved attitude score by 26% post-intervention, compared to only 11% improved in general ward nursing. This can likely be due to higher exposure to patients and more direct experiences with diabetic foot complications in such environments, making training more directly applicable.

Educational background was also a contributing factor. The most positive attitude scores were demonstrated by bachelor's degree nurses post-intervention, with a significant F-value statistic of 4.176 and p-value .018. This is in line with Kaya and Karaca's (2018) conclusion that university-educated nurses exhibited greater evidence-based practices as well as receptivity to training opportunities. In this research, mean attitude scores at post-intervention were 3.72 (SD = 0.44) for bachelor's degree nurses and 3.42 (SD = 0.48) for diploma holders. Years of practice also contributed significantly. The most positive attitude scores were demonstrated by nurses with 6–10 years of practice, with an accompanying F-value statistic at 3.941 and p-value at .011. This

demonstrates consistency with research by Nisa et al. (2019), with mid-level-experienced nurses (5–10 years) proving most receptive to diabetic foot care training, an age where confidence within clinical practice is matched by receptiveness to new techniques. A 21% shift towards more positive attitude was recorded post-training among that practice group.

Overall, the education program was successful in changing nurse attitudes towards diabetic foot care for the better. However, this level of advancement was determined by various demographic factors. This is reinforced by repeated outcomes in research from other countries placing greater attention on targeting education interventions to suit professional maturity, workplace environment, and socio-cultural factors. Nurses aged 31–40 and with 6–10 years of experience likely benefited from a combination of clinical confidence and motivation to grow. Male nurses' higher post-intervention scores might suggest differences in learning accessibility or fewer external constraints. ICU and diabetic clinic nurses likely perceived the training as more applicable, while bachelor's degree holders—often equipped with stronger academic preparation—appeared more receptive to evidence-based modules.

Taken together, these findings underline the value of personalized learning approaches in healthcare education. Programs that consider age, experience, educational level, and workplace setting are more likely to generate consistent and equitable improvements in clinical attitude and, ultimately, patient care outcomes.

5.11 The Sixth Research Question

The sixth research question "What is the relationship between practice levels of nurses and demographic characteristics regarding diabetic foot care among Jordanian nurses pre and post online educational program?" yielded significant findings regarding the relationship between demographic factors such as age, gender, years of experience, qualification, hospital region, and clinical work unit, and nurses' practice behaviors both before and after the educational intervention.

Before the educational program, no statistically significant associations were found between nurses' practice scores and their demographic characteristics, as revealed by the One-Way ANOVA and t-tests. For instance, no significant differences were observed across regions ($F = 0.951$, $p = 0.389$), age groups ($t = 0.203$, $p = 0.840$), gender ($t = 0.261$, $p = 0.795$), or years of experience ($F = 0.682$, $p = 0.606$). These results suggest that, prior to the program, diabetic foot care practices were relatively uniform, regardless of demographic factors. This uniformity, while initially seeming positive, highlights a critical limitation in clinical practice standards, pointing to a systemic deficiency in the emphasis on diabetic foot care in nursing education and practice across Jordanian public hospitals. Nurses likely operated from a shared baseline of limited training and institutional guidance, resulting in broadly similar, but insufficient, practices. This finding is consistent with research by Felix et al. (2021), which similarly found that nurses in low-resource

settings exhibited uniform knowledge and practice patterns, reflecting a lack of targeted education in diabetic foot care. After the educational program, there were statistically significant differences in practice levels among several demographic groups. There were large regional differences ($F = 5.500$, $p = 0.005$) with the highest post-program practice scores among nurses from the Middle region. The age of the nurses also made a difference with practice scores slightly higher in 20–30-year-olds compared to their older counterparts ($t = 2.600$, $p = 0.011$). Also, differences by gender became a concern with slightly higher levels of practice in males compared to those of women ($t = -2.200$, $p = 0.030$). These findings show how demographics affect the success of an intervention and how there exists a call for targeted interventions to correct differences. This may reflect stronger institutional support, higher engagement, or better accessibility to the training materials in that region compared to the North and South.

The result is consistent with those of Ramzan et al. (2022) and Baleegh et al. (2024) that differences were statistically different by age, region, and gender for studies that had identical educational interventions. Specifically, for example, Ramzan et al. (2022) reported that younger nurses had improvements that were higher on practice scores because they are relatively accepting of intervention programs. Similarly, Baleegh et al. (2024) reported that diabetic specialist center nurses had higher improvements on practice due to the provision of training material that was directly applicable to everyday duties.

Such findings affirm that there is a need for programs that take demographic differences into account in a bid to have the biggest possible impact. Instances of continuing education and support at the institutional level are also necessary to ensure that a benefit from such intervention is uniformly derived by all the nurses regardless of their demographics.

Practice After the Educational Program The findings from this study demonstrated statistically improved practice in diabetic foot care among participating nurses as a consequence of the online training program. However, these improvements were not uniformly distributed among all categories of demographics. Rather, levels of change were significantly different depending on regional, personal, and professional considerations as verified by statistical assessment. Significant differences in practice scores emerged by region ($p = .005$), age group ($p = .011$), gender ($p = .030$), work unit ($p = .001$), qualification ($p = .010$), and years of experience ($p = .007$).

Nurses from the Middle region of Jordan recorded the highest post-intervention practice scores, suggesting a possible link between local healthcare infrastructure and the successful uptake of training. This regional difference may reflect disparities in access to digital tools, institutional support, or exposure to diabetic foot cases. Comparable findings were noted by Schoen et al. (2016), where rural Australian nurses participating in a targeted intervention reported a significant increase in diabetic foot care practices—from 34% pre-intervention to 95% post-intervention ($p <$

0.001)-. This supports the present study's suggestion that contextual proximity to real cases enhances training applicability.

Age also emerged as a determinant of post-training practice behavior. Nurses aged 20–30 years reported the highest post-program practice scores ($p = .011$). This result aligns with findings by Nisa et al. (2019), who observed that younger nurses, particularly those under 30, were more likely to engage with and apply new clinical practices following a training session, reflecting their adaptability to technology-based learning. Younger participants made greater practice score improvements through training by 23%, while a 14% practice score improvement was recorded among older participants. These findings corroborate that digital fluency and an attitude towards openness to innovation are predictive measures that have a decisive impact on program success. Although the difference is modest, it suggests younger nurses may have been more receptive to new practice guidelines introduced during the program.

Interestingly, gender differences were found to be statistically significant ($t = -2.200$, $p = .030$), with male nurses demonstrating slightly higher practice scores than female nurses. This disparity may be attributed to several factors, such as differences in confidence levels or the application of acquired skills. Social and familial responsibilities that women often bear could also influence how they allocate their time and effort to engage with training content, especially in work environments that demand childcare or household duties. Additionally, women may face extra challenges related to social and cultural pressures, which could impact their attention and engagement with training. It is also important to note that women may have limited access to professional development opportunities due to these familial obligations or surrounding societal constraints. These differences highlight the need for further research to better understand how social and gender-related factors influence the effectiveness of educational and training programs in nursing, ensuring equitable opportunities for all participants. While Bilal et al. (2018) did not find any significant gender-based variance in diabetic foot practice ($p > 0.05$), the contrast may highlight unique sociocultural dynamics in Jordan. Female nurses in most Middle Eastern contexts will have more domestic duties as well as less discretionary time, restraining them from interacting intensively with e-learning systems or trying out new approaches on the job. These conclusions suggest there is a necessity for gender-aware training designs taking into consideration structural disparities and outside obligations.

Work unit had a most evident effect on practice outcomes. The most significant improvements in diabetic foot care practice were shown by nursing staff on surgical wards and medical wards, with less change reported by nursing staff on outpatient clinics ($p = .001$). This is supported by Ramzan et al.'s (2022) study, in which nursing staff in inpatient wards for treating surgical wounds improved mean practice score from 2.7 to 4.1 ($p < 0.001$), with outcomes in nursing staff in outpatient facilities only improving by 2.5 to 3.2. Increased exposure to more critical or complicated cases involving diabetic foot complications may have motivated these inpatient nursing staff to implement acquired skills more directly and urgently. Academic

level of qualification also had an influence on outcomes. Graduates with bachelor's and master's degrees scored higher on practice scores than those with diplomas ($p = .010$). This is consistent with Kaya and Karaca (2018) who found that those with higher levels of education scored higher on diabetic foot practice. Bachelor's degree holders scored a mean of 3.87 on the practice assessment ($SD = 0.41$) compared to a mean of 3.21 for the diploma holders ($SD = 0.56$). These findings reveal that greater education encourages critical thinking, exposure to evidence-based protocols, and confidence as a professional—both key factors behind practice transformation.

Experience was an influential factor, yet with a non-linear relationship. Practitioners with over 15 years' exposure reported lower practice scores than less experienced practitioners ($p = .007$). This is partially supported by Fujii and Stolt (2020), whose research discovered that Japanese senior home-care nurses only demonstrated slight improvements in practical outcomes post-intervention training. The authors concluded that habitual behaviors and bureaucratic duties commonly restrict receptivity and adoption by senior staff. These findings suggest that behavioral change management strategies, such as peer mentoring and reflective sessions, should be integrated into training programs, especially for long-serving professionals.

In summary, the online educational programme significantly improved nurses' diabetic foot care practices overall, but the degree of impact varied according to nurse profile, including socio-demographic factors, territorial context, educational background and experience. These findings reinforce that education cannot be one-size-fits-all. Demographically sensitive educational approaches that take into account age, gender, role, qualifications and experience are essential to ensure equitable improvement across all professional groups. Effective practice change requires more than information provision; it requires cultural adaptation, institutional support, flexible learning design and ongoing mentoring, particularly for nurses in less advantaged roles or contexts.

5.12 The Seventh Research Question

The seventh research question, "Is there a relationship between the knowledge, attitudes, and practices among Jordanian nurses regarding diabetic foot care pre and post online educational program?" explored how the three domains of knowledge, attitude, and practice (KAP) interact with one another in the context of a structured web-based training. To analyze the relationships between these variables, a Pearson Correlation Coefficient was used to assess the strength and direction of the associations between the pre- and post-intervention scores for each of the KAP domains. This statistical test was chosen because it effectively measures the degree to which changes in knowledge, attitudes, and practices are related to one another in a continuous, linear fashion.

Understanding the interplay between these domains is essential not only for evaluating the comprehensive impact of the program but also for guiding the design of future interventions aimed at sustaining clinical change. The analysis revealed statistically significant positive correlations

between knowledge, attitudes, and practices post-training ($p < 0.001$ for all domains), suggesting that improvements in one domain were associated with improvements in the others. These results underline the effectiveness of the online educational program in enhancing all three aspects of KAP simultaneously, paving the way for more integrated and sustainable changes in diabetic foot care practice.

Before the educational intervention, the relationships among KAP were weak and inconsistent. The correlation between knowledge and attitude was negative and statistically non-significant ($r = -0.107$, $p = 0.254$), indicating that knowledge, as it existed prior to the training, did not translate into more favorable professional attitudes. The association between attitude and practice was similarly insignificant ($r = 0.048$, $p = 0.608$), suggesting a disconnect between what nurses believed and what they implemented in care. Only a weak but statistically significant relationship was found between knowledge and practice ($r = 0.195$, $p = 0.036$), implying that while some knowledge was being translated into practice, the link was tenuous and likely influenced by other factors such as institutional norms or routine habits.

Following the training, all relationships strengthened, becoming statistically significant and moderate in magnitude. The correlation between knowledge and attitude improved to $r = 0.218$ ($p = 0.019$), while the correlation between knowledge and practice rose to $r = 0.271$ ($p = 0.003$). The strongest relationship was observed between attitude and practice ($r = 0.207$, $p = 0.027$). These results show that gains in knowledge were not isolated; they were accompanied by shifts in perception and behavior, which points to the overall coherence and effectiveness of the training approach. The findings validate the KAP model and correspond with other theories like the Theory of Planned Behavior (Ajzen, 1991) that argue that attitude intervenes in the process connecting belief and action.

These results concur with previous research that has also investigated the correlation among KAP areas across diabetic foot management. For example, Fujii and Stolt (2020) established that learning acquired through educational materials for in-home care nurses was moderately correlated with better practice after intervention, with a strong correlation in areas involving foot examination and patient counseling. Our study observed statistically significant correlations that paralleled the framework and aim of this intervention. In like fashion, AbdElshafy et al. (2024) reported a positive correlation between training and practice immediately following training ($r = 0.476$, $p < 0.001$) and even a month thereafter ($r = 0.472$, $p = 0.001$), reflecting long-term learning influence when training involves reinforcement strategies and integration into practice contexts.

Lilly-West's 2019 research in Nigeria's Rivers State also corroborates those targeted interventions can consolidate the connection between what is known by nurses and what is performed by them. Her research documented an extensive increase in practice regarding diabetes foot care after receiving a day's hands-on training, though there were less obvious changes in attitude. In contrast, this study demonstrated balanced development across all three areas, most

probably because of its design as a web-based training that introduced clinical information with reflective questions, multimedia case scenarios, and exercises involving real-life application.

Not all research reports such congruence. For instance, Bilal et al. (2018) and Nisa et al. (2019) reported no correlation at all between attitude and knowledge among samples of Pakistani nurses, a finding that implies that possessing knowledge may not be enough to correct long-held beliefs or priorities or alter professional values. This suggests cultural or structural impediments may water down the emotive or motivational adoption of fact-based materials. Conversely, this research indicates that when knowledge is provided in an accessible, personalized, and reflective form, then it is likely to influence practice as much as attitude.

The consistency with which pre-intervention deficit scores across these nurses—irrespective of age, sex, geographic area, or years of practice—highlight a systemic deficit in training on diabetic foot care. Before the intervention, the cohort demonstrated limited knowledge, moderate attitudes, and suboptimal practices. These patterns reflect long-standing underinvestment in wound care education and an absence of institutional prioritization. The program's success at turning around these patterns is noteworthy. The improvement on all three dimensions after intervention was statistically significant and, most tellingly, clinically significant. Correlation strength between the KAP variables also strengthened, which indicates that the intervention helped create a holistic professional identity for diabetic foot care among the nurses.

The outcomes of the present study indicate the effectiveness of the instructional program to improve the knowledge and attitude of the nurses toward diabetic foot management. The positive correlations found for the various components of the Pentagon Model indicate that the program was effective to improve the knowledge and application of diabetic foot management concepts of the participants. The statistically significant correlation indicates that the knowledge and attitude of the respondents with the instructional program had enhanced appreciably on the specific areas of Pathology, Etiology/Evaluation/Education, and Therapeutic Footwear.

It is important to observe that causation is not necessarily implied from a correlation, but the study design is informative regarding the interdependency among changes in knowledge, attitudes, and practice. The findings indicate that the training program effectively facilitated changes in the behavior and attitude of the nurses. The effectiveness of the program in bringing about better attitudes and knowledge, without establishing causation, indicates that the program was generally a success at fulfilling its purpose.

Although the correlations were statistically significant, it is important to recognize that managerial support, clinical workload, and team dynamics may also play important roles in influencing how nurses integrate the learned material into their daily practice. These external factors, while not the focus of this study, could further enhance the effectiveness of future training programs.

In conclusion, this study underscores the efficacy of the educational intervention, showing that it had a substantial positive impact on nurses' understanding and attitudes toward diabetic foot care, while also laying the groundwork for future research into the directionality of these effects. The success of this program demonstrates the value of continuing to implement targeted educational initiatives to improve the care of diabetic patients.

In conclusion, the analysis of relationships between knowledge, attitudes, and practices following the online educational program confirms the value of integrative professional development. The program did more than inform; it reshaped attitudes and improved practice, and perhaps most importantly, it reinforced the dynamic interconnection between cognitive, emotional, and behavioral domains of nursing care. These findings support the continued use of KAP-based frameworks in educational design and call for more nuanced, adaptive approaches that strengthen each domain while deepening their mutual reinforcement.

5.13 The Eighth Research Question

The eighth research question "Is there a relationship between the concepts of Amit Jain's Diabetic Foot PENTAGON Model among Jordanian nurses pre and post online educational program?" was central to understanding how deeply the structured intervention influenced clinical comprehension and application across specialized domains of diabetic foot care. The Pentagon Model, proposed by Amit Jain, is a comprehensive, multi-domain framework designed to guide both clinical practice and educational efforts around diabetic foot management. It comprises eight interdependent domains: Pathology, Etiology/Evaluation/Education, Novel Dressings, Therapeutic Footwear, Amputation/Antibiotics, General Status, Offloading, and a "Never Give Up" attitude.

For question eight, the relationship between nurses' understanding of the Pentagon Model and their demographic characteristics was analyzed. A Paired-Samples t-Test was employed to compare the scores pre- and post-intervention, specifically assessing changes in knowledge and application across the eight domains of the model. This statistical test was chosen because it is appropriate for comparing two related groups—the same group of nurses before and after participating in the educational program. The Paired-Samples t-Test helps assess whether there was a statistically significant difference in the nurses' understanding and application of the Pentagon Model following the educational intervention.

The results showed significant improvements across several domains, with Pathology, Etiology/Evaluation/Education, Novel Dressings, Therapeutic Footwear, and Amputation/Antibiotics demonstrating the largest increases (all with p-values < 0.001), while other domains, such as General Status and Never Give Up, showed minimal changes ($p = 0.421$ and $p = 0.145$, respectively).

These findings confirm the effectiveness of the online educational program in enhancing nurses' comprehension of diabetic foot care, as it relates to the Pentagon Model.

The results demonstrated a statistically significant increase in six out of eight domains post-intervention, emphasizing the effectiveness of education in building procedural and technical knowledge. For example, on Pathology, there was greater recognition by nurses of diabetic foot lesions, most notably osteomyelitis and slough, with statistical results registering high levels of significance ($p < 0.001$). This indicates that diagnostic acumen was successfully honed by the intervention—something also evidenced by AbdElshafy et al. (2024), with diagnostic accuracy by nurses having improved from a mean score value of 14.22 to 24.91 post-intervention ($p < 0.001$).

One particularly robust gain was made in the Etiology/Evaluation/Education area, with an increase in mean score from 20.91 pre-program to 30.18 post-program ($p < 0.001$). Not only does this demonstrate greater biomedical knowledge regarding ulcer causation, it also indicates greater confidence in teaching—such an integral preventive measure. These results are in line with those reported in the study by Suleiman et al. (2024), whose over 9-point rise in nurses' post-training scores for evaluation and teaching indicates that structured interventions can have a valuable impact on both explanatory potential and teaching confidence within clinical practice.

Significant gains were also made in Novel Dressings and Therapeutic Footwear, with scores improving with high statistical significance ($p < 0.001$). Nurses demonstrated better knowledge regarding dressing types specific to wounds and how pressure-redistributing shoes may be used to reduce realteration post-intervention. These outcomes are echoed by Baleegh et al. (2024), whose research also discovered improved dressing choice knowledge by 38% and orthotic use knowledge by 41% post-training. These outcomes in aggregate speak to the real-world applicability of hands-on learning with the use of the Pentagon Model.

The Antibiotics/Amputation domain also improved, with scores going up from 13.56 to 18.01 at post-intervention ($p < 0.001$). The domain is particularly vital because prompt intervention can reduce lower limb amputations by quite a large degree. This is corroborated by Lilly-West (2019) whose interventional study recorded a 27% increase in scores regarding nurses' management of antibiotics and a 33% rise in scores regarding concepts on when surgical referral would be most appropriate.

The Offloading domain—treatment strategy to shift pressure from ulcer sites—had a considerable increase as scores went from 4.10 to 5.11 ($p < 0.001$). The same trend was also noted in Fujii and Stolt's (2020) research, where more than 80% of nurses reported confidence regarding offloading recommendations post-simulation training compared to just 43% pretraining.

Conversely, two areas of the Pentagon Model did not improve significantly post-intervention. The General Status domain, involving screening for systemic comorbidities like obesity and vision

impairment, remained stable. This is indicative either that baseline levels were already adequate or that training through this program didn't adequately emphasize greater systemic assessments. The same also holds true for the "Never Give Up" motivational domain—Psychological resilience and endurance—where no significant gains were noted ($p > 0.05$). This corroborates with a limitation noted in earlier studies, including that by Suleiman et al. (2024), where emotional and motivation changes were least sensitive to traditional e-learning methods, pointing to greater interactive or reflective modalities for inducing personal commitment and long-term caring attitudes.

While there is limited prior research applying the Pentagon Model in the context of nurse education, this study stands out as one of the first to comprehensively employ the model for training and assessing clinical improvement among nurses. Its novelty is evident, as few empirical studies have operationalized all domains of the Pentagon structure in an educational setting. The structure enabled a multidimensional evaluation of the online program's effectiveness and offered a blueprint for aligning educational content with the complex realities of diabetic foot care.

This limited precedent also reinforces the contribution of the current research. By empirically validating the applicability of the Pentagon Model in an online nursing education program, the study contributes to both theory and practice. It demonstrates the model's utility in structuring technical content, assessing progress across a spectrum of clinical competencies, and identifying gaps that may be missed in traditional KAP frameworks.

In conclusion, while the online education program significantly improved nurses' understanding and clinical readiness across most Pentagon domains, it fell short in fostering psychosocial resilience and holistic patient evaluation. These findings highlight the model's potential as a framework for future curricula and suggest enhancements through simulation, case-based learning, and integrated motivational training. The research not only confirms the worth of the model but also gives a pragmatic guide on how to utilize it for enhancing diabetic foot care training worldwide.

5.14 Implication for Nursing Knowledge, Attitude, and Practice

The results from this research validate that an education program with a targeted, online platform notably enhanced Jordanian nurses' diabetic foot care KAP. There was an equal deficit in these areas beforehand, irrespective of background demographics. Post-training results demonstrated clear and statistically significant gains in all three areas. Knowledge scores improved most prominently in areas related to pathology recognition, wound dressing, and antibiotic usage. Attitude shifts were especially noted in groups aged 31–40 and among ICU staff, while practice improvements were highest among nurses in medical and surgical units.

These outcomes confirm the interdependence between KAP components: as knowledge increased, attitudes became more favorable, and practice scores rose accordingly. The moderate positive correlations between KAP domains support the theoretical framework guiding this research—namely, the Knowledge-Attitude-Practice model. This suggests that successful diabetic foot care requires not only technical expertise but also internal motivation and a belief in the value of one's clinical role. Therefore, educational strategies must be designed not just to inform, but also to inspire and empower

5.15 Implications for Nursing Education

The efficacy with which the online education program was able to yield measurable changes in diabetes foot care attests to its suitability as a scalable model for in-service and continuing education. That it is accessible to regions, departments, and levels of experience further testifies to the value of digital tools in widening the scope of professional development opportunities. Yet unequal distribution of post-program gains similarly suggests that not all nurses derive equal benefit from equal interventions.

Future nursing educational efforts need to take into consideration sensitivities in demographics. For example, younger generations may require interactive and reflective learning styles, while older generations may require support for change management and leadership coaching. Nurses in lower-engagement settings, such as outpatient clinics, may benefit more from case-based learning and interdisciplinary exposure. Moreover, areas such as motivational reinforcement, emotional resilience, and psychosocial care—which saw limited improvement in the current study—should be prioritized through modules that incorporate simulation, mentorship, and dialogue.

The study also validates the integration of the Pentagon Model as a pedagogical structure. Though few educational programs have used Amit Jain's model in structured nursing training, the present findings demonstrate that it can serve as a comprehensive, domain-specific framework for teaching and evaluating diabetic foot care. The use of the Pentagon Model added depth to clinical skill development, offering a structured and sequential method for understanding pathology, intervention, and patient-centered care.

5.16 Implications for Nursing Administration

The emergence of significant differences in learning outcomes across demographic and organizational categories has important implications for nurse managers and administrators. The study highlights that institutional culture, access to resources, and leadership support significantly mediate how educational interventions are received and internalized. Nurses who work in under-resourced departments or face work-life challenges—particularly female nurses balancing caregiving roles—may require additional administrative support to engage fully in training.

Therefore, hospital leadership should not only facilitate access to education but also foster environments that enable its application. Offering flexible schedules, setting aside dedicated learning time, and considering participation in professional development as part of performance appraisal can make learning an integral part of nursing practice. In addition, constant coaching, feedback, and clinical audits can reinforce learned practices within day-to-day workflow, and thus promote long-term behavioral change outside the classroom or online platform.

5.17 Future lines of research

This research opens up potential lines of investigation on two fronts: on the one hand, everything related to the need to seek strategies that allow for improving the educational levels of nurses responsible for caring for patients with diabetes in order to reduce the rates of complications and mortality related to the disease.

Secondly, it is necessary to emphasize the importance of closing the gender, territorial, and age gaps, especially those that our work has demonstrated among Jordanian nurses. Therefore, obtaining results based on scientific evidence in this regard can be very beneficial for a well-trained, professionally empowered nursing system that can achieve significant advances in the health status of the population.

5.18 Implications for Future Educational Programming

The development of statistically significant post-training differences highlights an important realization: standardized programs, regardless of how elegantly designed, will not have an equal impact on all learners. The future must embrace both diversity and flexibility. This means creating learning paths tailored by geography, department, career level, and personal situation. Tailored learning pathways may help ensure that no nurse is left behind due to structural or social limitations.

Moreover, while this study showcased promising short-term gains in KAP, long-term effects remain unknown. Future research should involve longitudinal tracking to determine the durability of educational outcomes. Exploring the comparative effectiveness of hybrid or in-person formats may also reveal insights about modality-specific strengths and learner preferences.

In conclusion, the online program effectively elevated the knowledge, attitudes, and practices of Jordanian nurses regarding diabetic foot care. It demonstrated that digital platforms, when rooted in a robust theoretical model like the Pentagon, can produce real and meaningful change. More importantly, it illustrated that learning is not merely the transmission of content, but a dynamic process shaped by emotion, motivation, environment, and experience. By recognizing

and addressing these complexities, nurse educators and administrators can build more responsive and equitable systems that empower every nurse to deliver high-quality, patient-centered diabetic foot care—now and into the future.

5.19 Recommendations and Conclusion

What this research suggests is that a single, 'cookie cutter' training strategy, as helpful as it is at lifting overall standards, is unlikely to narrow the learning gap in every demographic and institutional setting. Intentional interventions are required. Scenario training or clinical rotations shall be made available for the nurses working at low-participation settings like outpatient departments. Guided mentorship may help early-career nurses consolidate nascent attitudes and practices. Structural changes, for example, flexible schedules for education or provision of child care, may help with obstacles to taking regular training for women nurses.

Region-specific interventions addressing infrastructural inequalities—such as uneven availability of the internet or lack of organizational support—must be factored into program design. The varying post-training performance across regions suggests that inequalities at a systemic level affect the efficacy of training. These must be eliminated to ensure even opportunities for learning as well as prevent knowledge gaps in professionals that can affect patient safety.

Although this research noted promising attitude changes, it is not clear how long these gains will last without reinforcement. Attitudes are as much a product of workplace environment and leadership as they are an educational product. Therefore, follow-up interventions should incorporate modeling by leadership, reflective practices, and motivational interviewing to stabilize and maintain attitudinal change.

5.20 Final conclusions:

The findings of the study demonstrated the efficacy of the online training programme in enhancing the knowledge of nurses working in the Jordanian healthcare sector. The programme was designed based on the Pentagon Model, a comprehensive framework for foot care in patients with diabetes.

1. The online training programme was found to enhance nurses' positive attitudes regarding the importance of caring for patients with diabetic foot disease. The findings of the study demonstrate the efficacy of the implemented pentagon model in impacting nurses' psychological and behavioral dimensions.
2. The online training program, based on the dimensions of the Pentagon model, had a significant impact on improving nurses' clinical practices related to caring for patients with diabetic foot disease, highlighting the effectiveness of linking theoretical knowledge with practical application.

3. The findings revealed statistically significant differences in knowledge and practice levels post-training, depending on demographic variables such as academic qualification and current workplace, underscoring the importance of tailoring training programs to the characteristics of the target audience.
4. The Pentagon Model has been demonstrated to be an effective framework for the design of training programmes that aim to develop cognitive, practical and behavioral aspects of nursing staff.
5. The study recommends the adoption of the Pentagon Model in the development of specialized training programmes in nursing care, with a particular emphasis on high-risk areas such as preventive care for diabetic patients. It further encourages the implementation of this model in analogous contexts at both the local and regional levels.

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7 APPENDICES

APPENDICES

7.1 Appendix A
Participation in a Research Study

Dear Participant:

I am a researcher, Mohammad Ahmad Musa al-Meani, a PhD student at the University of Valencia, doctoral program in nursing /line of research: intervention in the clinical setting.

I conducted a study entitled:

(Effectiveness of Online Educational Program on Nurses' Knowledge, Attitude, and Practice Toward Diabetic Foot Care in Jordan)

Aim of the Study

This study aims to compare the levels of knowledge, attitudes, and practice of the nurses about diabetic foot care before and after the online educational program. In addition, to assess the relationships between nurses' demographic characteristics and nurses' knowledge, attitudes, and practice of DF care pre and post-online educational program.

The Role of Participation in the Study:

If you choose to participate in this study, all you have to do is fill in the approval form and fill out the questionnaire .If you want to get any inquiries, do not hesitate to contact the researcher. The attached questionnaire takes approximately 20 minutes to complete. There is no compensation for the response, and there is no risk of a favor. To ensure that all information remains confidential, not including your name, copies of the search results will be provided to Supervisors at the University of Valencia.

Note that participation in this study is optional, and you can withdraw at any time without giving reasons, as you will deal with the information completely confidential and will be kept after memories in a safe place.

Thank you for your response in advance.

Researcher Name: Mohammed Ahmad Al-me'ani

Mobile Phone: +962776676750

email address: moahmou@alumni.uv.es

Supervisors:

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Dr. Julio Fernandez Garrido,

Dr. Zeinab Mohammad Hassan Al-Wahsh.

Dear Participants

Thank you for agreeing to take part in this aspect of our research. If you are interested in participating in the second stage, which will be conducted as lectures online educational program about diabetic foot ulcer care, please provide a phone number and email.

Your Email:

Phone Number:

Participation Information Sheet

You are invited to take part voluntarily in this research. This research is about the Effectiveness of an Online Educational Program on Nurses' Knowledge, Attitude, and Practice Toward diabetic foot care in Jordan.it is important that you read and understand this research information before agreeing to participate in this study. This study is estimated to include up to 70 participants.

Subject Information and Consent Form

To become a part of this study, you or your legal representative must sign this page. I am confirming the following:

I have read all the information in this research information and consent form including information regarding the risk in this study, and I have had time to think about it.

All my questions have been answered to my satisfaction.

I voluntarily agree to be part of this research study, follow the study procedures, and provide necessary information to the research team.

I may freely choose to stop being a part of this study at any time

I have received a copy of this subject information and consent form to keep for myself

Participants Material Publication Consent Form

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To become a part of this study, you or your legal representative must sign this page. I am confirming the following:

I understood that my name would not appear on the published materials, and there have been efforts to ensure that my name is kept private and confidential. However, confidentiality is not entirely guaranteed due to unexpected circumstances.

I have read the materials or general descriptions of what the material contains and reviewed all photographs and figures I have included that could be published.

I have been offered the opportunity to read the manuscript and see all the materials included, but I have waived my right to do so.

The published materials will be shared among the research team, experts, and journalists worldwide.

The materials will also be used in local publications and books and accessed by many local and international doctors worldwide.

The materials will not be used for advertising purposes or as packaging materials.

The materials will not be used out of context.

7.2 Appendix B
Study Questionnaire

The questionnaire consists of four sections: Section A is about socio-demographic characteristics. Section B is about the assessment of nurse's knowledge of diabetic foot ulcers. Section C is About the attitudes of nurses towards diabetic foot ulcers. Section D is about the practice of nurses towards Diabetic foot ulcers.

Agreement

□ Agree

□ Disagree

APPENDICES

Questionnaire on Assessment of Nurses' Knowledge, Attitudes, and Practice on Diabetic Foot Ulcers

This questionnaire takes only 20 minutes to complete, Please follow the instructions given under each section to answer questions.

Section A (Socio-Demographic Data)

Please indicate the information applicable to you by marking an" X" in the appropriate box. If "other" is selected, please elaborate in the box with the dotted line.

1. **Hospital Name :**
2. **Age:**

□ 20-30 □ 31-40 □ 41-50 □ 51-60 □ 61 or more

3. **Gender:**

□ Male □ Female

4. **Current Working Unit:**

□ Surgical Ward □ Medical Ward □ ICU Unit □ Outpatient clinic □ Emergency Room □ Diabetic foot clinic \ Diabetic Clinic

5. **Level of Nurse Qualification:**

□ Basic Diploma □ Bachelor's Degree □ Master and above

6. **Nursing Experience**

□ ≤ 5 years □ 6-10 years □ 11-15 years □ 16 ≥ years.

7. **How would you rate your current level of wound care knowledge?**

□ Excellent knowledge □ Good knowledge □ Satisfactory knowledge □ Fair knowledge □ Poor knowledge

8. **Do you have any special training in wound care (e.g., diabetic foot care)?**

□ Yes □ No

Section B (Assessment of Knowledge)

This section contains questions on knowledge about diabetic ulcers and ulcer care. Please encircle the correct option. Each question has only one correct answer.

1. **I think diabetic ulcer treatment is more important than ulcer prevention.**

   a. True b. False c. Don't know

2. **I do not think it is necessary to assess diabetic wounds regularly.**

   a. True b. False c. Don't know

3. **Neuropathy is the predominant factor responsible for diabetic ulcers.**

   a. True b. False c. Don't know

4. **Sensory neuropathy may result in ulcers forming.**

   a. True b. False c. Don't know

5. **Neuropathy is associated with dry skin which predisposes to ulcer formation.**

   a. True b. False c. Don't know.

6. **Diabetic neuropathic ulcers are typically found on weight-bearing areas of the foot.**

   a. True b. False c. Don't know

7. **Neuropathy can be excluded if the foot skin is cool and pulses are absent.**

   a. True b. False c. Don't know

8. **The risk of amputation is higher when a diabetic foot ulcer is associated with limb ischemia.**

   a. True b. False c. Don't know

9. **Presence of slough is not an indication of infection in diabetic ulcers.**

   a. True b. False c. Don't know

10. **Presence of osteomyelitis impairs the healing of diabetic ulcers.**

    a. True b. False c. Don't know

11. **Change to offloading treatment should facilitate ulcer healing.**

    a. True b. False c. Don't know

12. Infected wounds should be cleansed daily.

a. True b. False c. Don't know

13. Dressings are effective in healing wounds with clinical signs of infection.

a. True b. False c. Don't know

14. **Hydrogel dressings are useful to rehydrate the wound bed and control the moisture in wounds. e.g., Intrasite gel**

a. True b. False d. Don't know

Section C (Assessment of Attitude)

Using the following 5-point scale, please indicate the extent of your agreement or disagreement with the following statements. Mark "×" in the column for each statement.

Item	Strongly Agree	Agree	I don't know	Disagree	Strongly Disagree
1. Diabetic wound care is time-consuming for me to carry out.	□	□	□	□	□
2. In comparison with other areas of nursing care, diabetic wound care is a low-priority task for me.	□	□	□	□	□
3. If I have the opportunity, I would like to avoid caring for diabetic wounds.	□	□	□	□	□
4. I have time to advise each patient individually on how to look after their wounds.	□	□	□	□	□
5. It is my responsibility to educate patients with diabetic ulcers on how to reduce re-ulceration.	□	□	□	□	□
6. I think about pain when cleaning diabetic wounds.	□	□	□	□	□
7. I like to care for diabetic wounds in my practice.	□	□	□	□	□
8. I am satisfied with caring for diabetic wounds.	□	□	□	□	□

Section D (Assessment of Practice)

This section contains questions on practice about diabetic ulcers and ulcer care.

-Using the following 5-point scale, please indicate the extent of your agreement or disagreement with the following statements. Mark "×" in the column for each statement.

Item	Always	Often	Sometimes	Rarely	Never
1. I assess patients at risk for diabetic foot ulcer for signs like pain, skin status, vascular status, and loss of protective sensation and check for deformities.	□	□	□	□	□
2. I assess foot ulcer wound for depth, length, and size.	□	□	□	□	□
3. Assess of muscular skeletal system for patient during diabetic foot care.	□	□	□	□	□
4. I can assess foot for hygiene (cut toenails, unwashed feet, superficial fungal infection, and unclean socks).	□	□	□	□	□
5. I assess the patient for physical examination such as visual acuity and obesity.	□	□	□	□	□
6. I perform education session for patient and family.	□	□	□	□	□
7. I make sure routine wear appropriate footwear (wide, without excessive pressure on the skin, and fit).	□	□	□	□	□
8. I debride necrotic tissue and the surrounding callus.	□	□	□	□	□
9. I select appropriate dressing according to diabetic foot ulcer condition.	□	□	□	□	□
10. I clean nails with appropriate instrument or nail cutter.	□	□	□	□	□
11. I measure patient feet size when last bought footwear.	□	□	□	□	□
12. Using the appropriate offloading devices for patients.	□	□	□	□	□

7.3 Appendix C
Ethical permission from MOH in Jordan

وزارة الصحة

الرقم MOH/REC/2022/110
التاريخ .....
الموافق .....

قرار لجنة أخلاقيات البحث العلمي

اجتمعت لجنة أخلاقيات البحث العلمي بتاريخ ٦/ ٢٠٢٢/٤ لمناقشة ودراسة البحث العلمي المقدم من طالب الدكتوراه / محمد احمد موسى المعاني .

بعنوان:-

"فعالية البرنامج التعليمي عبر الانترنت على مستويات المعرفة والسلوك والممارسة لدى الممرضين تجاه العناية بالقدم السكرية في الأردن "

وبناءً عليه قررت اللجنة الموافقة على إجراء البحث العائد للمذكور أعلاه مع الالتزام بأخلاقيات البحث العلمي ، وتم التوقيع من قبل أعضاء اللجنة حسب الأصول.

مقرر اللجنة وحدة تنمية الموارد البشرية السيد/ اكرم العناتي	عضو المدير الطبي د. حسن صريوع	عضو الصيدلاني حنان سرطاوي	عضو أخصائي جراحة عامه د جهاد بربراوي
عضو رئيس قسم الباطني د. يوسف القديمات	عضو مدير مديرية المختبرات د. معاذ بدوي	عضو أخصائي الأطفال د.عصام الخواجا	عضو مدير الشؤون الادارية والمالية والتمريض / د.هاني القضاة

رئيس اللجنة

مدير ادارة مستشفيات البشير

الدكتورعلي عزات العبداللات

APPENDICES

7.3.1 Translation to English language the Ethical permission from MOH

وداد بسام الحسيني
مترجمة محلفة
Wedad Bassam ILhuseini
Traductora Jurada – Sworn Translator

WEDAD BASSAM ILHUSEINI
LEGAL TRANSLATION OFFICE

LEGAL TRANSLATION FROM ARABIC TO ENGLISH

MINISTRY OF HEALTH
Ref. No.: MOH/REC/2022/110
Date:

DECISION OF THE RESEARCH ETHICS COMMITTEE

The Research Ethics Committee convened on **April 6th 2022** to discuss and review the research proposal submitted by the PhD candidate, Mr. **MOHAMMAD AHMAD MOUSA ALMEANI**.

entitled:

"Effectiveness of Online Educational Programme on levels of Knowledge, Attitude and Practice among nurses Toward Diabetic Foot Care in Jordan."

Accordingly, the Committee has decided to **approve the implementation of the aforementioned research**, subject to full compliance with the ethical standards governing scientific research.

The decision was duly signed by the members of the Committee in accordance with the established procedures.

Committee Rapporteur Human Resources Development Unit Mr. Akram Al-Anati /firmado/	Member Medical Director Dr. Hasan Matawa'eh /firmado/	Member Pharmacist Hanan Sartawi /firmado/	Member Specialist in General Surgery Dr. Jihad Barbarawi /firmado/
Member Head of the Internal Medicine Department Dr. Yousef Al-Qudaimat /firmado/	Member Director of the Directorate of Laboratories Dr. Moath Badawi /firmado/	Member Pediatric Specialist Dr. Issam Al-Khawaja /firmado/	Member Director of Administrative, Financial, and Nursing Affairs Dr. Hani Al-Qudah /firmado/

Chairman of the Committee
Director of Al-Bashir Hospitals Administration
Dr. Ali Izzat Al-Abdallat
/firmado/

Certification:
"Mrs. Wedad Bassam ILhuseini, a sworn translator of Arabic-English-Spanish, licensed by the Commission de Media, certifies that the foregoing is a true and complete translation into English of a document written in Arabic.
In Amman, on May 15, 2025."

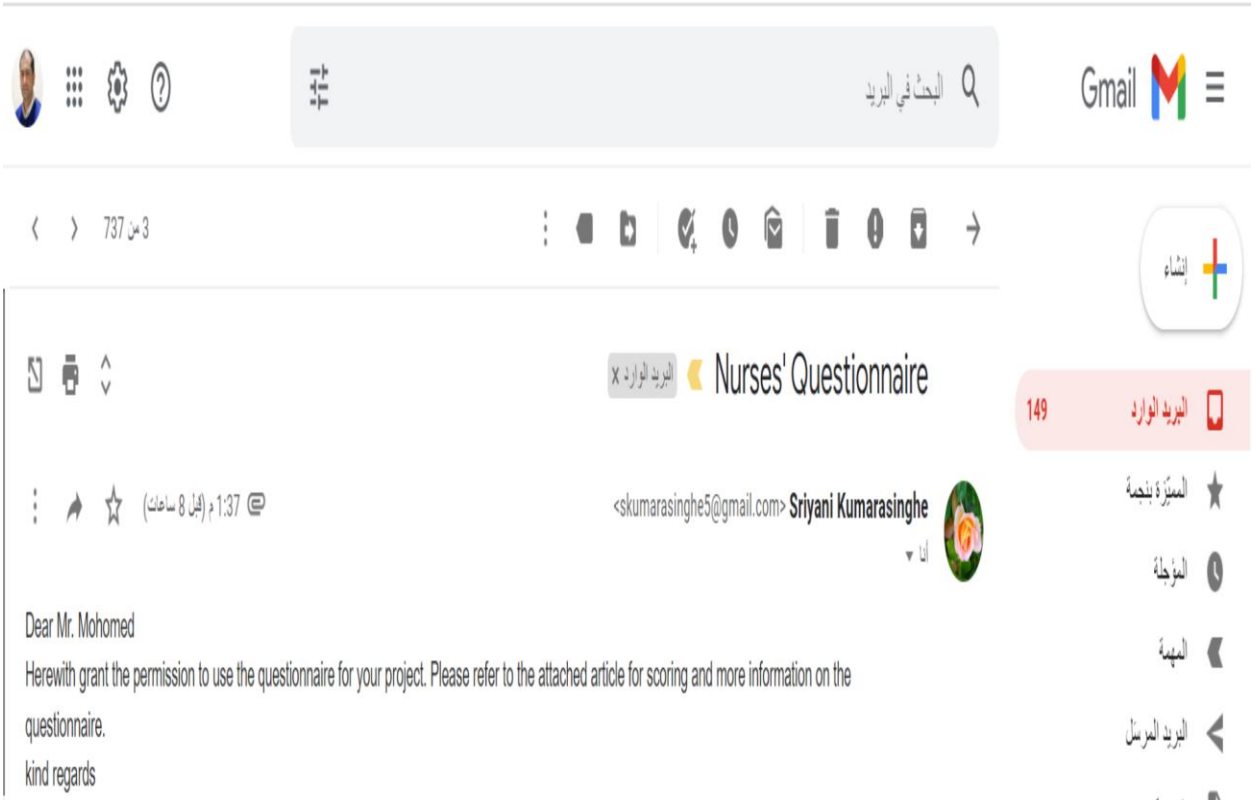
Seal of the Translator:

وداد بسام الحسيني
مترجمة محلفة
Wedad Bassam ILhuseini
Traductora Jurada – Sworn Translator

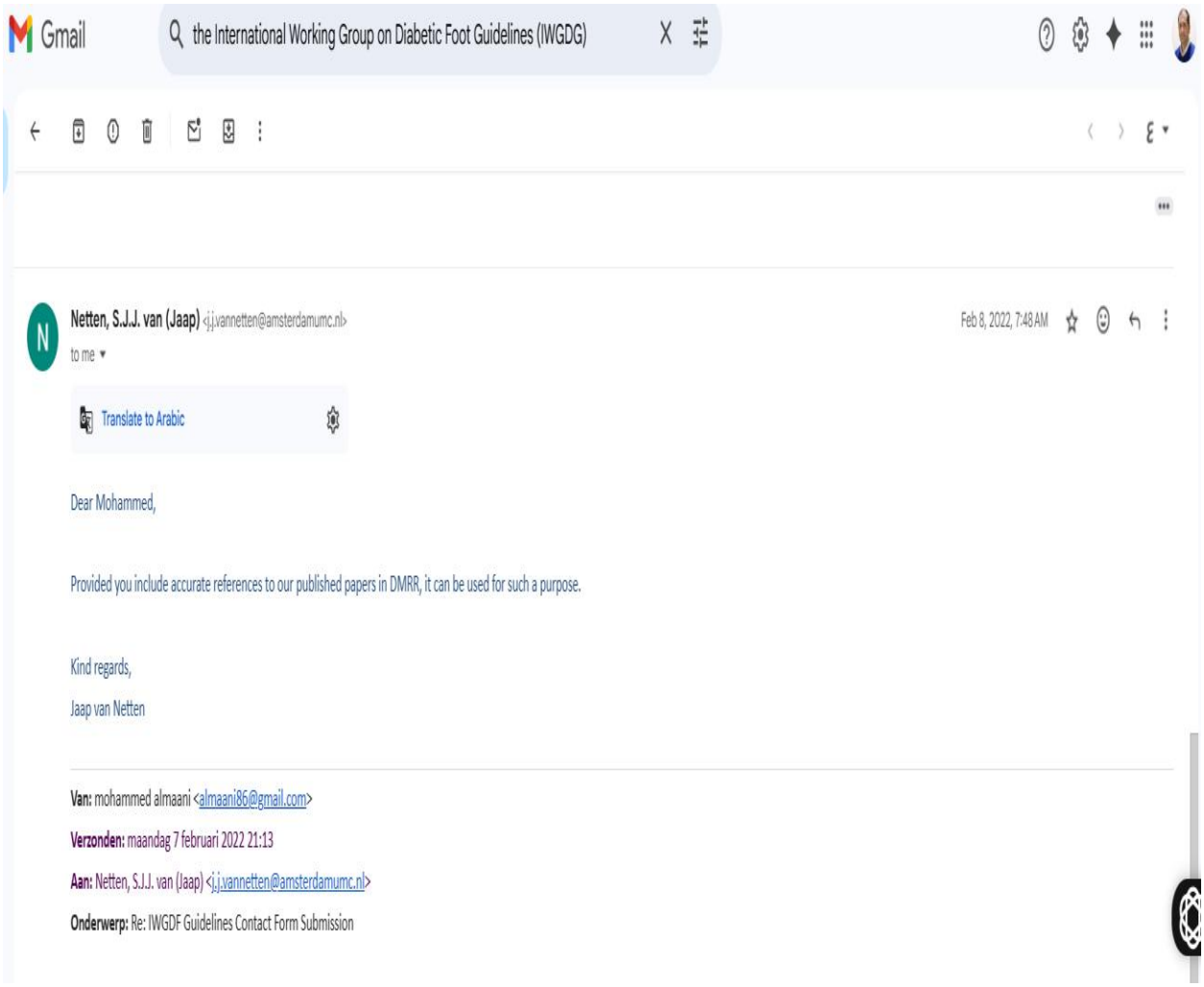
Reg. N° (MNI/192), ID: 9949005473,
Email: wedadalhuseini@gmail.com, Mobile: +962790189800, Amman, 11194, Jordan

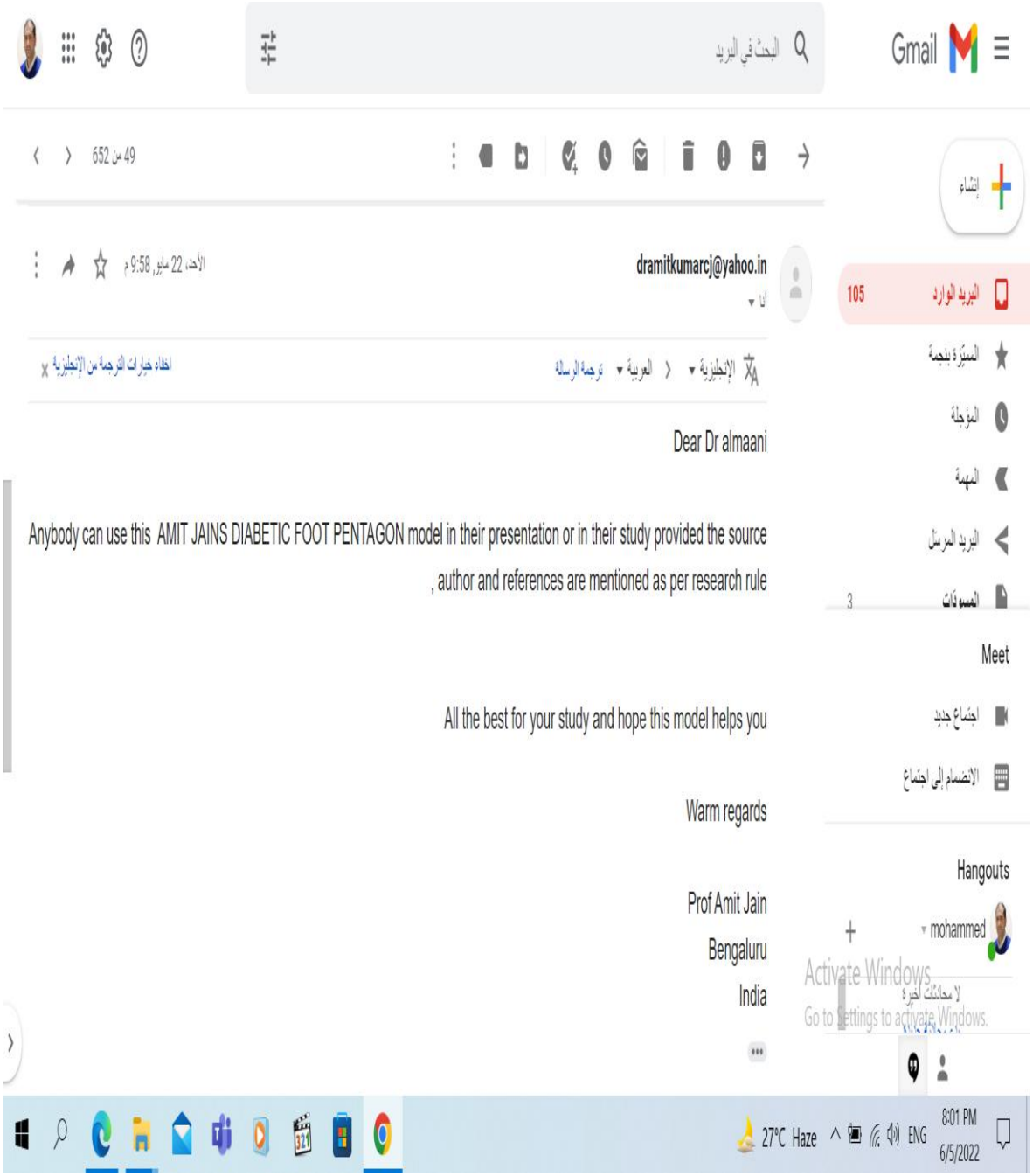
7.4 Appendix D

Permission to Use Tool



7.5 Appendix E
Permission from the IWGDG



7.6 Appendix F

Permission to Use the Diabetic Foot PENTAGON Model