

The Effect of Lean Training Program for Head Nurses on their Knowledge, Readiness for Lean Transformation and Lean Culture in Healthcare

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Abstract

Lean management, rooted in the Toyota Production System (TPS), takes a holistic approach. It emphasizes innovation, efficiency, and customer value while prioritizing quality, safety, satisfaction, and morale within health organizations. Rather than solely cost-cutting, Lean aims for sustainable improvements. This research **aimed to** investigate the effect of lean training program on head nurses' knowledge, readiness for lean transformation, and lean culture in Kafr EL- Dawar General Hospital. **Methods:** Quasi-experimental design was used in 31 units affiliated with Kafr EL- Dawar General Hospital. two groups of subjects participated in the study: all head nurses (HNs) (N= 60), and 250 convenient sample from different nursing qualifications (e.g. diploma, technical, baccalaureate) who are working in the 31 units affiliated with Kafr EL- Dawar General Hospital. Data had collected using four tools: Lean Knowledge Questionnaire (LKQ), Individual Readiness for Lean Transformation Questionnaire, Lean Culture Dimension Framework (LCDF), and Training Program Evaluation Questionnaire (TPEQ). **Results:** statistically significant differences had found in HNs overall lean knowledge level and readiness level for lean transformation immediately post and after three months of the training program implementation ($p < 0.05$). Also, statistically significant differences had found in nurses' perception of overall lean culture after three months of the lean training program implementation ($p < 0.05$). HNs recorded the lowest percentage of readiness for lean transformation at the principal support dimension. **Conclusion:** The Lean Training Program significantly improved knowledge level, readiness level for lean transformation among HNs. As well as Nurses' perception of lean culture in Kafr El Dawar General Hospital. The findings highlighted the effectiveness of the Lean Training Program in enhancing lean practices and fostering a culture of continuous improvement within healthcare organizations. **Recommendation:** future longitudinal studies will shed more light on the causal relationship between Lean knowledge, readiness, and lean culture in healthcare.

Key words: Lean Training Program, Head Nurse, Lean knowledge, Readiness for Lean, Lean culture, Lean Transformation, Healthcare.

INTRODUCTION

Global competition has forced healthcare organizations to provide quality healthcare services to their customers faster and at competitive prices. Egyptian Ministry of Health attempt to improve safe and healthy system that satisfies patients within the framework of the vision of political leadership and Egypt's 2030 strategy for sustainable development. To achieve these goals, healthcare organizations must compete with modern healthcare standards such as continuous improvement or lean management. Therefore, healthcare organizations can improve patient safety, quality of care, efficiency, patient satisfaction and productivity by applying Lean principles (Van Rossum et al., 2016).

According to Graban (2009) and Graban (2016) lean can be defined as a quality and process improvement methodology and an integrated system of principles, practices, tools, and

techniques, based on the Toyota Production System (TPS), that maximize value, eliminate waste, improve performance and quality, emphasize customer needs, and reducing time delays and costs; all through continuous improvement and employee involvement.

A good healthcare system should be designed in a way that does not disrupt people's daily lives. For this reason, the concept of lean in healthcare services is important in terms of planning the process and using resources effectively. lean in healthcare centers on shortening patients' waiting time, adding value to patients, increasing patient's safety, and ensuring that the patient's journey to quality care is smooth and efficient. Therefore, lean ensures the organization of processes and the efficient use of resources. In addition, the implementation of lean methods in healthcare focused on redesigning the patient's journey to improve access and reduce waiting times

and managing the medical supply chain (**Andreamatteo et al., 2015**).

Lean system recognizes both Value-Added (VA) and Non-Value Added (NVA) activities in healthcare processes. From the patient's perspective, value-added activities are important. NVA activities, on the other hand, are activities for which patients are not willing to pay money and spend time and resources. Therefore, the basis of lean philosophy is the elimination of waste that does not add value to the service (**Hallam & Contreras, 2018**). In this respect, the lean system identifies various categories of waste namely, over production, defects, waiting times, transporting, inventory, excess processing, motion, and underutilized staff. Health care, waste can mean errors, waiting, inaccurate information ... etc. (**Hallam & Contreras, 2018**).

Womack and Jones 1996, identifies five principles of lean thinking can be summarized in: precisely specify value from customer perspective, identify the value stream for each service, make value flow without interruptions, let the customer pull value from the producer, and pursue perfection (**Womack & Jones, 2003**). Therefore, lean has the potential to be a powerful transformation platform for healthcare organizations in this time of revolutionary change. Likewise, it is surrounded by a balanced approach combining technical, managerial, and philosophy; these taken together will transform to organizational lean culture (**Toussaint, 2015**).

Accepting the framework of **Modig and Åhlström (2012)** the knowledge on lean, that is being implemented in healthcare as well, can be described as a set of fundamental elements, such as tools and activities, methods, principles and values, all means to comprehend a lean strategy. **Radnor et al. (2012)** describes the nature and the aim of these different tools, methods and activities referring to the necessity of assessing, acting, and monitoring results. Indeed, there is first the need to assess the processes at the organization level, using tools such as process mapping, value definition and value stream mapping. Other tools are useful in trying to reach the targeted objectives of change, such as 5S (sort, set in order, shine, standardize, and sustain), daily meetings, rapid improvement events (Kaizen events) and visual management. monitoring results of planned actions A3s, problem solving, standard work, visual management and workplace audit could be used (**Hallam & Contreras, 2018**).

Nurses are ideal leaders of a lean transformation in healthcare organization. They have experience leading multiple-disciplinary teams, are well trained, and are system thinkers. Also, nurses who

seek to be leaders need vigorous reserve of knowledge and a deep skills portfolio to do lean works that go far beyond their traditional role (**Toussaint, 2015**).

The successful lean transformation requires announcing, explaining and preparing healthcare providers to be ready for this change and the impact of the implemented change especially in early stage before a lean transformation starts (**Rosa et al., 2021**). Readiness to lean is one of the constructs that promotes nurses' positive behaviors, attitudes and thinking towards innovation. nurses' readiness for lean change is defined as the nurses' beliefs, attitudes, and intentions regarding the extent to which lean changes are needed and the ability of the organization to achieve these changes (**Magalhães et al., 2016**). In this respect, **Holt et al. (2007)** identified five dimensions that constitute readiness for lean change; these include personal valence, self-efficacy, discrepancy, appropriateness, and principal support. (**Al-Balushi et al., 2014**)

Valence refers to whether the nurse perceives the lean change to be personally beneficial. Self-efficacy shows the nurse's beliefs that they can contribute to the lean change. Discrepancy expresses nurse's belief in the necessity of change. Appropriateness reflects that nurses must believe that lean change is right and suitable for the organization. Finally, Principal Support shows that nurses need to understand whether the organization provides support and leadership for Lean change (**Al-Balushi et al., 2014**). Although the role of managers and their readiness for lean is important, it is not possible to ignore crucial factors such as lean culture, which is one of the most crucial factors that can directly affect the lean journey. since the organizational culture and management are interrelated these can create real obstacles in lean transformation's path (**Al-Najem et al., 2012**).

Mann (2014) defined the lean culture in an organization as the sum of all individuals' work-related behaviors in the organization, reflected in Lean Culture Dimension Framework (LCDF) that enables organizations to recognize whether their culture is healthy enough to cope with lean by understanding cultural weaknesses and strengths that can addressed with lean. it also makes them realize how far their organizations are from lean culture (**Mann, 2014**). LCDF has seven main dimensions that describe lean culture including continuous improvement, processed focused, mutual respect and trust, involvement, consistency, mission, and adaptability.

Continuous improvement helps managers and nurses use a set of tools to improve their work. process focused enables the organization to identify

distinct types of waste and ways to reduce it. mutual respect and trust significantly affect organizational culture because it determines how management and staff interact and the level of trust in the organization and management. involvement displays the participation level of the organization's members in decision making (Mann, 2014). Consistency demonstrates purpose and meaning by defining the organization's social responsibility and external goals and increasing its chances of survival, growth, and development. Adaptability explains the extent to which the organization changes its behavior, structure and systems to survive in an uncertain environment (Salah et al., 2014).

Internationally, a study was conducted in United Kingdom by Al-Najem et al. (2012) to examine the role of culture and leadership in lean transformation and verified that organizations can't succeed in lean unless they have a healthy culture, skilled workers, and a strong leadership. Another study was done in United States USA by Mazur et al. (2011) to investigate the change and sensitivity in recipients buy-in on implementation of lean methodology for operational improvement at three rural hospitals. Moreover, a study conducted in 2018 in Kuwait by Boswihi (2018). About the effect of lean leadership training program on head nurses' performance and patients' satisfaction; and found that there were statistically significant differences in the head nurses' performance and knowledge; and in patient satisfaction before and after the training program implementation.

In Egypt, a study conducted in 2018 by Gaafer (2018) examined the effect of implementation of lean strategies utilization training program for first line nurse managers on quality of environmental and occupational safety. Another study done by Abou hashish and Abdel aal (2019) explored the effect of lean awareness on nurses' knowledge and readiness for lean transformation in the hospital. Furthermore, a study conducted by Helmy et al. (2023) investigated the Effect of Training Program about lean strategies for head nurses on their leadership effectiveness.

Significance of the study:

However, most of previous research started to assess and implement lean regardless understanding the staff knowledge, readiness, and organizational culture that lean requires, and ignored preparation of staff through training and development. All these factors have a significant role in the journey of lean transformation. So, the present study will fill this gap by spreading the lean concept and philosophy and stressing the importance of lean culture and readiness for lean transformation to promote continuous improvement

and efficiency. It is hoped that this research will focus on the significant role of first line nurse managers' knowledge and readiness in successful implementation of lean in healthcare organization which will subsequently reduce nonvalue added activities in process, improve flow of services and ensure customer satisfaction.

This study aims to:

- Investigate the effect of lean training program on head nurses' knowledge, readiness for lean transformation, and lean culture in Kafr EL-Dawar General Hospital

Research Hypothesis:

the lean training program has an effect on the head nurses' knowledge, readiness for lean transformation, and lean culture in kafr el-dawar general hospital.

Operational Definitions:

Lean Training Program: A structured educational initiative designed to equip HNs with the knowledge, skills, and tools necessary to apply Lean principles and practices within their hospital.

Head Nurses: Are frontline nursing leaders who manage the day-to-day operations of nursing units or departments. They play a critical role in managing staff, patient care, and resource allocation. They also are responsible for implementing lean practices to improve efficiency and quality in healthcare.

Readiness for Lean: This term describes the HNs' beliefs, attitudes, and intentions regarding the extent to which lean changes are needed and the ability of the organization to achieve these changes.

Lean Culture: A workplace environment characterized by Lean thinking, collaboration, and a commitment to continuous improvement. A Lean culture fosters a mindset of efficiency, quality, and customer value.

Lean Transformation: The process of fundamentally changing an organization's operations, culture, and mindset to align with Lean principles. It involves implementing Lean tools, streamlining processes, and creating a sustainable culture of continuous improvement.

Research design:

A Quasi-Experimental Research Design had utilized to conduct this study.

Research Setting:

The study had conducted in Kafr EL-Dawar General Hospital, Al Behera Governorate. It

include 31 units divided into; medical care units (n=3), surgical care units (n=5), intensive care unit (ICU) (n=4), pediatric care unit (PCU) (n=1), pediatric intensive care unit (PICU) (n=1), neonatal care unit (NCU) (n=1), emergency unit (n=1), dialysis (n=1), operative units (n=4), obstetric care unit (n=1), ophthalmology (n=1), ear nose throat ENT unit (n=1), burn unit (n=1), urology unit (n=1), endoscopy unit (n=1), hematemesis unit (n=1), toxicology unit (n=1), physical therapy unit (n=1), and outpatient care unit (n=1 contain 17clinic). It considered the only general governmental hospital affiliated to the Ministry of Health with 276 beds.

Research Subjects:

The subject of the study divided into two groups of convenient samples as follow:

- All HNs who are working in the previously mentioned units at the study time (N= 60).
- Staff nurses: a convenient sample of different nursing qualifications (e.g. diploma, technical, baccalaureate) who are working in the previously mentioned units (N= 250) out of 522 nurses.

The sample size estimated using Epi Info software program with expected frequency =50%, margin of error 5% and confidence coefficient level 95%.

Tools of the study:

Four tools were used in this study as follow:

Tool I: Lean Knowledge Questionnaire (LKQ):

It was developed by the researcher, based on the review of related literature (Al-Balushi et al., 2014; Al-Najem et al., 2012; D'Andreamatteo et al., 2015; Graban, 2009; Hallam & Contreras, 2018; Helmy Elsayed et al., 2023; Salah et al., 2014; Toussaint, 2015) to assess Filner's knowledge regarding lean concept, principles, methods and strategies before and after lean training program. It was divided into 3 parts as follows: Part I: Multiple Choice Questions: include 15 questions scored (15score). Part II: Matching questions scored (15score): divided into three groups: the first was *Lean tools* (scored 5) ask about the meaning of 5 lean tools as follow: (Gemba, PDCA, The A3 report, Kaizen, Value stream mapping).

The second was *Lean principles* also contain 5 questions (scored 5) require the description of the 5 lean principles (Define Value, Map the Value Stream, Create Flow, Pursue Perfection, and Establish Pull. While the third was *Five S_s* likewise involve 5 questions (scored 5) represents the signification of each S from the five S_s (Sort, Set in Order, Shine, Standardize, Sustain). Part III: True and False questions include 10 questions scored (10 score). The overall score is 40 points = (100%), correct answer scored "1" point

and, incorrect scored zero. Scoring Satisfactory level about 60% and more, while dissatisfactory <60%.

Tool II: Individual Readiness for Lean Transformation Questionnaire:

It was developed by the researcher based on the review of related literature (Andersen, 2008; Hallgrímsson, 2008; Mann, 2009; Mazur et al., 2011; Radnor et al., 2012). To better fit the contextual richness of the readiness, change of first line nurse managers involved in the lean transformation. It involved 33 items evaluating five dimensions including personal valence (n=7), self-efficacy (n=7), discrepancy (n=6), appropriateness (n=6), and principal support (n=7). Responses measured on a 5-point Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree). The mean score from 33 to 77 considered low readiness, mean score from 78 to 121 considered as moderate readiness, while, and mean score from 122 to 165 regarded as high readiness. This tool was modified after validity and reliability testes that resulted to 33 items and there were 9 items that were removed as follow: 7 statements Removed because repeated with a same meaning with others, one statement removed because it is a general statement, and two statements Integrated into one.

Low readiness	<33.33%
Moderate readiness	33.33% - 66.66%
High readiness	>66.66%

Tool III: Lean culture Dimension Framework (LCDF):

It was developed by Salah et al. (2014) to assess the organizational lean culture dimension and adopted by the researcher. It consists of 80 items measuring seven dimensions as follows; continuous improvement (n=18), processed focused (n=10), mutual respect and trust (n=8), employee involvement (n=16), consistency (n=13), mission (n=7), and adaptability (n=8). Responses had measured on a 5-point Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree). Mean score from 81 to 189 considered poor culture, mean score from 190 to 297 considered as moderate culture, and mean score from 298 to 405 regarded as good culture.

Poor lean culture	(<33.33%)
Moderate lean culture	(33.33% - 66.66%)
Good lean culture	(>66.66%)

- Tool I, and Tool II used for first line nurse managers HN.

- Tool III used to assess staff nurses' perception about lean culture.

In addition, a demographic characteristics data sheet developed by the researcher; it includes questions related to unit, age, gender, marital status, qualifications, and nursing experience.

Tool IV: Training Program Evaluation Questionnaire (TPEQ):

A structured form of questions developed by researcher (Al-Balushi et al., 2014; Al-Najem et al., 2012; D'Andreamatteo et al., 2015; Graban, 2009; Hallam & Contreras, 2018; Helmy Elsayed et al., 2023; Salah et al., 2014; Toussaint, 2015) to evaluate program out comes from first line nurse managers' point of view. It includes 25 questions to measure strength and weakness points related to program as follow: program objectives (n=2), the time of conducting the program and the program duration (n=1), Content of the program (n=7), the educational climate (n=4), the instructional materials and methods (n=7), in addition to 4 questions evaluate trainer's effectiveness. Responses measured on a 5-point Likert scale ranged from 1 (strongly disagree) to 5 (strongly agree).

II. Methods

1. An official permission had obtained from the Dean Faculty of Nursing, Damanhour University, and the responsible authorities of the study setting after explaining its purpose.
2. Tool III were translated into Arabic; and submitted in both Arabic and English languages to seven experts in the field of the study professors of nursing administration department to test the content validity and translation. Accordingly, the necessary modifications had done.
3. Tools of the study had assessed for its content validity by the seven experts in the field of the study. Consequently, the necessary modifications had done.
4. A pilot study for the quest
5. Questionnaire were carried out on 10% (n= 6) for HN, and (n= 25) for staff nurses; they are not included in the study; to ensure the clarity and feasibility of the tools, identify obstacles and problems that may be encountered during data collection as well as, estimate the time needed to fill the questionnaire. Then, the necessary modifications had done.
6. Tools of the study were tested for their reliability, by the Cronbach's alpha

correlation coefficient test to assess internal consistency of the items composing each tool, with value of (r = 0.78) for tool I, (r = 0.95) for tool II, (r = 0.99) tool III and (r = 0.97) tool IV.

7. Data collection:

- The study data had conducted in three phases as follow:

Phase (1): Assessment phase:

- Data had collected by the researcher tool II used for HNs (N=60), through self-administered questionnaires immediately before the implementation of the training program in training hall Kafr El Dawar general hospital. The time needed to fill the questionnaire was about 10 minutes.
- Tool III: was hand delivered to nurses (n=250) in their work units at morning and afternoon shifts at break times because of the availability of the considerable number of the study sample. The time needed to fill the questionnaire was 15-20 min.
- Data collection took about two months from 1-8-2022 to 30-9-2022.
- Needed instructions had given before the distribution of the questionnaires the study subjects assured by the researcher about their confidentiality of their responses. The researcher remains with them until the questionnaires had completed to ensure objectivity of the responses and to check that all items had answered.

Phase (2): Implementation phase:

- Tool I: used to assess the HNs' knowledge about lean immediately before conducting the training program in training hall at Kafr El Dawar general hospital. The time needed to fill the questionnaire was about 15 minutes.
- The lean training program had implemented for HNs in three days for theoretical contents at the training halls in Kafr EL- Dawar General Hospital and 2 days for practice in their units with total hours 16 hour. The HNs are divided into 4 groups according to their working schedule.
- The program implementation took about two months from 1-10-2022 to 30-11-2022.

The sessions included general and specific objectives, content, teaching strategies and methods.

The content of the lean training program presented the following topics:

- Lean history
- Lean concept and lean health care
- Benefits of lean healthcare
- Value and waste (value added and non-value added)
- Types of waste (Muda, Mora, and Mori)
- Lean tools and techniques (value stream mapping, Gemba walk, kaizen, 5Ss, fishbone analysis, PDCA cycle).
- Lean culture
- Lean transformation process

Teaching strategies and methods had selected according to each session's contents such as group discussion, brainstorming, scenarios, and videos, PowerPoint, and flipchart had used. The duration of one training day was four hours each day was divided into 2 sessions and a break for 15 minutes was arranged between each session.

Phase (3): Post-implementation phase:

Immediately:

- Tools I, and II has used again at the end of the training program to assess the effect of the training program on the HNs knowledge about lean, and their readiness for lean transformation.
- Tool IV has distributed immediately after the training program's implementation for HNs to determine their feedback toward the program from their point of view.

Three months post-implementation:

- A follow-up assessment has conducted after three months using tools I, II, for HNs to validate the effect of the lean training program on their knowledge and readiness for lean transformation. Tool III was hand delivered again for nurses (n=250) to assess the effect of the training program implementation on lean culture.
- This process took about 2 months from 1-3-2023 to 30-4-2023,

Statistical analysis

After data has collected it has revised, coded, and fed to statistical software IBM SPSS version 25. The reliability of the tools was determined by Cronbach's alpha. Frequency tables and cross-tabulation had used to illustrate the results. Quantitative data had summarized by the arithmetic mean, standard deviation, and mean score percent. All statistical analysis has done using

two-tailed tests and an alpha error of 0.05. A P-value less than or equal to 0.05 was statistically significant.

A. Descriptive statistical analysis: included the mean with standard deviation, Median, minimum, and maximum for the numeric data while percent to describe the frequency of each category for categorical data.

B. Inferential statistical analysis: The Pearson correlation test, the Spearman correlation test, Independent Samples Test, one way ANOVA, Mann Whitney test, Kruskal Wallis test, Repeated measures ANOVA, a one sample T Test, and Test of normality had used.

8- Ethical considerations:

- Before data collection, the approval of the Scientific Research Ethics Committee at the faculty has obtained at 17/9/2020 code no: 40-F.
- Before data collection, informed consent has obtained from HNs and nurses, for agreement to participate in the study to collect the necessary data.
- Anonymity of subjects was assured.
- The privacy of subjects has assured, and confidentiality of the data had maintained.
- The study subjects had told they have the right to withdraw at any time.

Limitations:

- It was a challenge to conduct a scheduled training sessions for HNs that were busy with the supervisory, technical, and administrative responsibilities in their units. However, the coordination and cooperation of hospital administrator, nurse manager and training coordinators of the hospital facilitated the implementation of the program.
- The program had conducted only for HNs and from one hospital. Though, during the practical training, the trainer encouraged the HNs to transfer some of the information acquired from the training to the nurses under their supervision. Additionally, nurses inspired to participate in the practical application in their departments. Therefore, generalization become limited. so, future studies should include all staff and different Setting.
- Sometimes training places were not available, and with the help of training coordinators, arrangements had done to reserve a suitable time for training.

RESULTS

Table 1 shows the Distribution of the Nurses according to their Socio-demographic, and work-related characteristics and revealed that; (53.3%) of the HN was between the Age group of 35 to less than 45, and all of them were female. Regarding Work Units, 13.3% were working in the Intensive Care Units. Concerning Level of education, 70% of the HNs had a Bachelor's degree in Nursing. 18.3% of them had a Master's degree in nursing science, while 11.7% had a Diploma in nursing science. With respect to years of experience, (33.3%) of the HN had between 15 to 20 years of experience in nursing. Also, about 30.0% of them had from 1 to less than 5 years of experience as HN.

This table also indicates that; 81.7% of HNs did not receive any quality-related training as well, 93.3% of them did not join any process improvement program. On the other hand, 18.3% had quality studies divided into; 36.4 % of them had TQM Courses and 63.6% of them had quality training. Over and above, 6.7% participated in process improvement programs.

Table 2 shows the Distribution of the Nurses according to their Socio-demographic, and work-related characteristics and describes that; most nurses who participated in the study were between 25 to over 45 years old. Additionally, the nurses from 25 to less than 35 years old represented the (31.6%). while only 16.8% of them were less than 25 years old. Regarding nurses' educational qualifications, 38.8% of the nurses had a Diploma of Secondary Nursing School. While 1.6% of them had post-graduate degrees. With respect to the work unit, (16.8%) of nurses were working in the Intensive Care Unit

Concerning Years of experience, (55.2%) of nurses had from 1 to less than 5 years of experience in their current work unit. Also, 29.2% of them had from 1 to less than 5 Years of experience in hospital. Additionally, 29.6% of them had 20 or more years of experience since graduation. In respect to receiving quality training, (91.2%) of the nurses did not receive any quality training, whereas (8.8%) of them had quality courses. As well as (0.4%) of them participated in improvement projects.

Table 3: Differences between mean scores HNs overall lean knowledge level and readiness level for lean transformation through the program phases illustrated there were statistically significant differences in HNs overall lean knowledge level immediately post and after three months of the training program implementation ($p < 0.05$). Concerning HN's readiness level for lean

transformation there were statistically significant differences in HNs readiness level for lean transformation immediately post and after three months of the lean training program implementation ($p < 0.05$).

As regards lean Readiness Dimensions, there were statistically significant differences in HNs' readiness level for lean transformation regarding all dimensions immediately post and after three months of the lean training program implementation ($p < 0.05$). On the other hand, there were no statistically significant differences in HNs lean knowledge level and readiness for lean transformation level between immediately post and after three months of the lean training program implementation ($p > 0.05$).

Table 4: Differences between mean scores of Nurses' perception of Lean Culture before and after 3 months of Lean Training Program implementation concluded that there were statistically significant differences in nurses' perception of overall lean culture after three months of the lean training program implementation ($p < 0.05$). As a same, there were statistically significant differences in nurses' perception of lean culture after three months of the lean training program implementation as regards all dimensions ($p < 0.05$).

Table5: Correlation Matrix between HNs Lean Knowledge level, Readiness level for Lean Transformation and Lean Culture Pre-Training Program implementation discussed that regarding the relationship between HNs' overall lean knowledge level and their readiness level for lean transformation, there were no statistically significant relationship between overall HNs lean knowledge, and their overall readiness level. On the other hand, there was a moderate statistically significant negative relationship with the principal support dimension, a weak statistically significant positive relationship with the valance dimension, and a very weak statistically significant positive relationship with efficacy dimension $R = -0.488$, 0.313 , and 0.147 , respectively.

Concerning the relationship between HNs overall Lean Knowledge level and Lean Culture Pre-Training Program implementation. there was a very weak statistically significant positive relationship between HNs overall lean knowledge level and lean culture $R = 0.154$. Additionally, there was a weak statistically significant positive relationship with continuous improvement dimension $R = 0.257$ and a very weak statistically significant positive relationship consistency dimension $R = 0.124$. **On the other hand, there was no statistically**

significant relationship between HNs Readiness for Lean Transformation level and Lean Culture.

Regarding the relationship between HNs Readiness for Lean Transformation level dimensions Pre-Training Program implementation, there was a very strong positive relationship between overall HNs readiness for lean transformation level with valance, efficacy, discrepancy, and appropriateness dimensions $r=0.875, 0.944, 0.968, \text{ and } 0.958$ in that order. And a strong positive relationship with principal support dimension $R=0.642$. **Furthermore**, the valance dimension had a very strong statistically significant positive relationship with efficacy dimension $R=0.894$, and a strong positive relationship with discrepancy, and appropriateness dimensions $R=0.777, \text{ and } 0.779$ in turn. As well as a Weak positive relationship with Principal Support $R=0.240$.

Moreover, there was a very strong statistically significant positive relationship between efficacy dimension with discrepancy, and appropriateness dimensions, in addition to moderate relation with principal support dimension $R=0.862, 0.869, \text{ and } 0.481$ respectively. **Likewise**, there was a very strong statistically significant positive relationship between discrepancy with appropriateness dimensions $R=0.934$ and a strong statistically significant positive relationship with principal support dimension $R=0.697$. In addition, the appropriateness dimension had a strong statistically significant positive relationship with the principal support dimension $R=0.642$.

Concerning the relationship between Lean Culture dimensions Pre-Training Program implementation very strong statistically significant positive relationship existed between overall lean culture with all culture dimensions; continuous improvement, process focused, mutual respect and trust, staff involvement, consistency, mission, and adaptability $R=0.844, 0.889, 0.862, 0.946, 0.955, 0.895, \text{ and } 0.910$ in that order. **In addition to** the continuous improvement dimension had a strong statistically significant positive relationship with process focused, mutual respect and trust, staff involvement, consistency, mission, and adaptability $R=0.716, 0.801, 0.704, 0.717, 0.645, 0.690$ correspondingly. Also, there were very strong statistically significant positive relationships between process focused with staff involvement, and consistency dimensions $R=0.817, \text{ and } 0.827$.

Moreover, strong statistically significant positive relationships have existed between process-focused with mutual respect and trust, mission, and adaptability $R=0.765, 0.719, \text{ and } 0.777$, respectively. **In the same way**, there were

strong statistically significant positive relationships have existed between mutual respect and trust with staff involvement, consistency, mission, and adaptability $R= 0.747, 0.775, 0.701, \text{ and } 0.707$ in that order.

Furthermore, staff involvement had a very strong statistically significant positive relationship with consistency, mission, and adaptability $R= 0.930, 0.861, \text{ and } 0.846$ in turn. **Likewise**, there was a very strong statistically significant positive relationship between consistency with mission, and adaptability $R=0.882, \text{ and } 0.877$ one-to-one. Finally, there was a very strong statistically significant positive relationship between mission and adaptability dimensions $R=0.906$.

Table 6: Correlation Matrix between HNs' overall Lean Knowledge level, Readiness level for Lean Transformation, and Lean Culture Post 3 months from lean Training Program implementation explained that regarding the relationship between HNs overall lean knowledge level and their readiness level for lean transformation there were a weak statistically significant relationship between HNs overall lean knowledge and their overall readiness level for lean transformation $R=0.352$. Also, there were weak statistically significant positive relationships with valance, efficacy, discrepancy, and appropriateness dimensions $R = 0.420, 0.298, 0.352, \text{ and } 0.406$, respectively. On the other hand, there was no statistically significant relationship between HNs Lean Knowledge level and principal support dimension.

About the relationship between HNs overall Lean Knowledge level and Lean Culture post 3 months from the lean Training Program implementation, there was no statistically significant relationship between HNs overall lean knowledge level and overall lean culture. Additionally, there was a very weak statistically significant positive relationship with staff involvement dimension $R=0.133$.

Regarding the relationship between HNs Readiness for Lean Transformation level and Lean Culture post 3 months from Training Program implementation, there was no statistically significant relationship between HNs readiness for lean transformation level and lean Culture. **Concerning the relationship between HNs Readiness for Lean Transformation level dimensions post 3 months from Training Program implementation** there was a very strong positive relationship between overall HNs readiness for lean transformation level with all dimensions valance, discrepancy, efficacy,

appropriateness, and principal support dimensions $R=0.883, 0.876, 0.939, 0.944,$ and 0.864 respectively.

In addition, the valance dimension had a very strong statistically significant positive relationship with discrepancy, and appropriateness dimensions $R= 0.851,$ and 0.853 in turn. Also, there was a strong positive relationship with efficacy dimension $R=0.720$. As well as a moderate positive relationship with Principal Support dimension $R=0.595$. Moreover, there was a strong statistically significant positive relationship between efficacy dimension with discrepancy, appropriateness, and principal support dimensions $R= 0.781, 0.701,$ and 0.762 respectively. **As well**, there was a very strong statistically significant positive relationship between discrepancy with appropriateness dimensions $R= 0.903,$ and a strong statistically significant positive relationship with principal support dimension $R=0.702$ Furthermore, the appropriateness dimension had a strong statistically significant positive relationship with principal support dimension $R= 0.789$.

Regarding the relationship between Lean Culture dimensions post 3 months from Training Program implementation very strong statistically significant positive relationships have existed between overall lean culture with all culture dimensions; continuous improvement, process focused, mutual respect and trust, staff involvement, consistency, mission, and adaptability $R=0.880, 0.917, 0.881, 0.926, 0.945, 0.900,$ and 0.810 respectively. **Moreover**, the continuous improvement dimension had a very strong statistically significant positive relationship with process-focused, and mutual respect and trust dimensions $R=0.875,$ and 0.837 respectively. As well as, it had a strong statistically significant positive relationship with staff involvement, consistency, mission, and adaptability $R=0.837, 0.720, 0.723, 0.713,$ and 0.618 correspondingly.

Likewise, there were very strong statistically significant positive relationships between process-focused with mutual respect and trust dimensions $R=0.874$. Also, strong statistically significant positive relationships have existed between process-focused with staff involvement, consistency, mission, and adaptability dimensions $R=0.668, 0.796, 0.755,$ and 0.790 respectively. In the same way, there were strong statistically significant positive relationships have existed between mutual respect and trust with staff involvement, consistency, mission, and adaptability dimensions $R= 0.732, 0.772, 0.725,$ and 0.656 in that order.

Furthermore, staff involvement had a very strong statistically significant positive

relationship with consistency, with mission dimensions $0.914,$ and 0.819 in turn. And a strong statistically significant positive relationship with adaptability dimension $R=0.687$. Moreover, there was a very strong statistically significant positive relationship between consistency with mission dimension $R=0.900,$ and a strong statistically significant positive relationship with adaptability dimension 0.801 . Finally, there was a very strong statistically significant positive relationship between mission and adaptability dimensions $R=0.834$.

Table 7: mean percent score of HNs evaluation of the lean Training Program immediately post the program implementation revealed that; the mean percent scores for all variables were more than 90%. Moreover, the highest mean percent score was (96.33 %) for trainer effectiveness. furthermore, the overall Training Program Evaluation (TPE) Mean percent score was (93.99%) which indicated that HNs had high mean percent scores regarding their opinions about the lean training program. All HNs were satisfied regarding the objectives, content, instructional materials, and methods of the lean training program, as well as, the educational climate, and the trainer's effectiveness. The mean percent scores were (90.33%, 94.67%, 95.24%, 91.00%, and 96.33%) respectively.

Discussion

The results of the current study illustrated statistically significant differences in the overall knowledge levels of HNs, with all results being satisfactory. The significant differences had observed between the pre-training and post-training phases. This marked improvement in knowledge levels is logical when compared to the preprogram phase due to the lack of prior training related to lean principles for hospital staff. Lean is a new concept, and HNs needed to update their knowledge and learn new techniques to enhance patient care and perform their duties more effectively.

However, there were no significant discrepancies observed between the immediate post-training phase and the three-month follow-up. This lack of variance could be attributed to the brief interval between the training program and the follow-up assessment. Additionally, HNs acquired sufficient knowledge about lean principles during the program, which motivated them to apply these principles in their respective units. The handouts and videos provided were beneficial in illustrating real-world scenarios. These results align with the findings of **Helmy et al. (2023)**, who reported a highly significant improvement in total head

nurses' knowledge mean scores about lean strategies after implementing the training program.

Similarly, **Mohamed et al. (2023)** found that the post-intervention and follow-up intervention phases had significantly higher mean scores compared to the pre-intervention phase, with statistically significant differences between all three program phases. Each pair of pre- and post-, pre- and follow-up, and post- and follow-up data also showed statistically significant mean differences (**Mohamed et al., 2023**).

Additionally, the study revealed a significant change in the readiness levels of HNs for lean transformation. Initially, most HNs exhibited moderate readiness before participating in the training program. However, post-program data showed a marked improvement, with the majority demonstrating high readiness levels immediately after the training and maintaining these levels three months later. This indicates a substantial positive shift in their preparedness to adopt lean principles and practices. This improvement can be attributed to the training program, which provided HNs with essential knowledge for lean implementation.

This newfound knowledge improved their perceptions of lean practices, bolstering their confidence in applying lean principles and underscoring the necessity for change. Consequently, HNs had motivated to pursue lean practices. The three-month period following the program allowed them to apply and hone their lean knowledge in practical settings, further enhancing their readiness for lean transformation. Therefore, it is not solely the lean knowledge from the training that increased the readiness of HNs.

The study confirmed this by showing that the highest percentages of HNs reported high readiness levels across all dimensions, with particularly high percentages in the Efficacy and Discrepancy dimensions. The most significant change has observed in the correlations involving efficacy, which increased notably with other dimensions post-training, indicating that efficacy is crucial in HNs' readiness for lean transformation after training. Conversely, the weak positive correlation between overall lean knowledge and readiness for lean transformation post-training suggests that initial knowledge may not strongly predict readiness. In conclusion, while knowledge may contribute to readiness to some extent, other factors such as perceptions, confidence, motivation, and efficacy are significant determinants of readiness levels for lean transformation among HNs.

These findings are supported by previous studies. **Holt et al. (2007)** argued that training programs enhance employees' confidence in adopting change initiatives and increase self-efficacy (**Mansour et al., 2022**). Furthermore, training programs make employees more psychologically prepared to implement changes, with increased self-efficacy translating into improved self-confidence in performing tasks in a new environment. Studies also indicate a significant positive relationship between employee training and self-efficacy (**Islam et al., 2020**).

Rafferty et al. (2013) noted that understanding the need for change and addressing discrepancies through provided information is crucial (**Rafferty et al. (2013)**). Also, **Ahmed Elsheshtawy et al. (2024)** emphasized that nurses' beliefs, values, attitudes, perceptions, and intentions are vital for successful change implementation in health organizations, with high levels of readiness factors among nurses (**Ahmed Elsheshtawy et al., 2024**). As well as **Holden et al. (2015)** confirmed that a clear understanding of lean principles and methods enhances readiness and motivates employees to contribute to waste reduction efforts (**Abou hashish & Abdel aal, 2019**). In contrast, **Abd-Elkawey and Sleem (2015)** found that most nurses had moderate readiness for change. Similarly, **Mangundjaya (2013)** reported the lowest mean in individual readiness for change. And **Ferrari (2023)** found no direct relationship between training activities and self-efficacy (**Ferrari, 2023**).

The findings of this study also highlighted that **principal support** had the lowest readiness percentage among the individual readiness dimensions of HNs. This suggests a potential challenge in maintaining consistent leadership support over time. While the training program may have initially boosted perceptions of support, sustaining prominent levels of support necessitates ongoing commitment and engagement from leadership. This finding aligns with the study by **Abou hashish and Abdel aal (2019)**, which reported that nurses rated the principal support dimension as the lowest among the Lean readiness dimensions. **Angelis et al. (2011)** also support this observation, explaining that employees are unlikely to be strongly committed to lean unless they experience support, respect, fair treatment, and involvement from top management (**Angelis et al., 2011**).

Mokhtar and Yusof (2016) emphasize that involvement and buy-in are critical features of a lean system to create an optimal working environment. To initiate this process, senior management must demonstrate full commitment by

providing necessary support, resources, budgets, and investment in employee training. **Kaplan and Haenlein (2010)** also identified essential requirements for successful lean adoption, including top-management support and leadership direction, multi-skilled workers, a culture that supports continuous improvement, clear responsibilities, a change agent, empowerment, and clear systems and controls to ensure a smooth transition from traditional management philosophies to Lean principles (**Al-Najem et al., 2012; Fournier et al., 2021**).

Regarding lean culture, there were statistically significant differences in nurses' perceptions of overall lean culture and its seven dimensions three months after the training program has implemented. Nurses viewed it as a positive culture, with their perception levels improving after three months. This suggests that even though the nurses did not directly participate in the lean training program, the involvement of HNs had a substantial impact on the nurses' perception of lean culture within their work units. This can be attributed to the crucial role HNs play as leaders in healthcare organizations. Their participation in a lean training program can lead to changes in their leadership style, communication patterns, and decision-making processes.

These changes can indirectly affect nurses' perceptions of lean principles and practices in their work units. The concept of "leading by example" suggests that employees often emulate the behavior and attitudes of their leaders. When HNs demonstrate a commitment to lean principles and practices, it can positively influence nurses' perceptions and behaviors within their work units. This underscores the significant role of leadership in shaping organizational culture and driving continuous improvement initiatives.

This has supported by the study finding that there was no significant relationship between lean knowledge and lean culture, except for a very weak correlation with staff involvement pre- and post-three months from the training program. Similarly, no statistically significant correlation has found between HNs' readiness for lean transformation and lean culture. Overall, the findings suggest that while lean knowledge and readiness for lean transformation may have weak associations with certain dimensions of lean culture, establishing a robust lean culture requires comprehensive organizational efforts beyond individual factors. These efforts include leadership support, employee engagement, continuous improvement practices, and aligning organizational values with lean principles.

In this regard, **Schein (2010)** illustrated that leadership behavior is a critical factor in shaping organizational culture and employee attitudes (**Xenikou, 2022**). **Radnor et al. (2012)** have shown that leadership commitment and behavior are key drivers of organizational culture change, including the adoption of lean principles. **Drotz and Poksinska (2014)** emphasized the importance of aligning leadership behaviors with lean principles to drive cultural transformation and sustainable improvements. Moreover, **Wang et al. (2018)** revealed that leaders co-shape their employees' behaviors and values. **Soltani and Wilkinson (2010)** observed that top leaders' lean-supportive behaviors influence subordinate leaders' behaviors, which in turn affect work floor employees. Social learning theory posits that people are more strongly influenced by proximal rather than distant others, suggesting that effective higher-level leaders can affect front-line leaders who then affect team behaviors and values (**Van Dun & Wilderom, 2021**).

Additionally, this result aligns with **Salah and Sayed (2015)**, who noted that a weak lean culture can be strengthened by providing appropriate awareness and training to leaders and employees by professional instructors. **Al-Najem et al. (2012)** concluded that organizations cannot succeed in lean unless they have a healthy culture, skilled workers, buy-in from top management, and strong leadership.

The findings of this study also revealed a strong statistical relationship between total lean culture and all its dimensions, as well as between the various dimensions themselves. This suggests that a robust lean culture has deeply integrated and interacts with several aspects of organizational culture. Such results highlight the interconnectedness and mutual reinforcement between lean principles and broader cultural elements within an organization. Research by **Salah and Sayed (2015)** and subsequent scholars on cultural dimensions provides a framework for understanding how different aspects of culture interact and influence organizational practices (**Salah & Sayed, 2015**). Additionally, the study found a strong statistical relationship between the total lean readiness level and all its dimensions. This result aligns with **Blizzard's** study, which revealed a highly statistically significant correlation between the overall mean score percentage of nursing staff's perception of organizational readiness for system adoption and its dimensions (**Poksinska, 2010**).

Regarding the overall TPE, the high scores suggest that most HNs had a positive perception of the lean training program. These

scores not only indicate the program's effectiveness but also reflect high satisfaction levels among participants. Notably, the highest mean percent score for trainer effectiveness highlights the trainers' success in delivering content in an engaging and comprehensible manner. Effective trainers significantly contribute to a training program's success by facilitating learning and engagement among participants (Chukwu, 2016).

The satisfaction of HNs with various aspects of the training program underscores the alignment between the program's objectives and the content delivered. It also indicates that the instructional methods were effective in imparting found that training effectiveness is influenced by the quality of instructional design, trainer expertise, and the relevance of content to participants' needs. Furthermore, the high satisfaction levels among HNs suggest that the lean training program successfully met their expectations and needs (Salas et al., 2009). McNamara (2016) the reason organization conducts training program is to prepare employees for the forthcoming changes that will happen in the future so that they can adjust easily to this change. Thus, it is important that during the design phase, the various training activities must be selected properly. This means it is important to select training activities that will improve the teaching and learning process.

According to McNamara (2016) organizations conduct training programs to prepare employees for future changes, enabling them to adjust easily. Therefore, selecting appropriate training activities during the design phase is crucial for improving the teaching and learning process. EL Hajjar and Alkhanaizi (2018) reported that a trainer's main goal is to motivate trainees and increase their desire to learn innovative ideas and skills. The positive support from trainers helps trainees learn and remember the material. This is essential for ensuring the transfer of learning from the training environment to the workplace, ultimately leading to improved performance and outcomes (EL Hajjar & Alkhanaizi, 2018).

Conclusion:

The implementation of the lean training program had a significant positive impact on the lean HNs lean knowledge, readiness for lean transformation, and lean culture. Before the training program, the HNs showed low lean knowledge and moderate readiness for lean transformation. However, after the program, their lean knowledge significantly improved, with all results being satisfactory, and their readiness for lean transformation significantly increased, with a majority showing high readiness. The nurses also perceived the hospital's culture as

the intended knowledge and skills. Additionally, HNs' feedback suggests that the learning environment fostered by the program was conducive to effective learning. A positive educational climate enhances motivation, engagement, and retention among participants. These findings are consistent with broader research on effective training program evaluation, which shows that factors such as clear objectives, engaging content, effective instructional methods, and a supportive learning environment are crucial for the success of training programs.

For instance, a study by Salas et al. (2009)

having a good lean culture both before and after the training program.

Recommendations:

For hospital administration:

- Top management support and effective communication are essential for implementing a lean approach in the healthcare industry. Establishing a culture of trust and commitment requires a durable foundation in open communication, transparency, and trust.
- HNs' preparedness for change improved by including them in the change process and attending to their concerns. Regular refresher training, mentoring programs, and continuous improvement projects are strategies to maintain HNs' knowledge.
- Healthcare companies that want to successfully implement lean transformation must address obstacles and difficulties.

For educational level:

- Lean approach and its branches should be introduced in nursing curriculum to acquaint students with up-to-date knowledge and skills in lean management and lean leadership strategies.

For further research:

- Conduct multi-site studies: To enhance generalizability, future research should involve multiple hospitals or healthcare settings to capture a broader range of organizational cultures and characteristics. Use mixed-methods approach, long-term follow-up, increase sample size, and consider additional outcome measures. Also, future research could explore the long-term impact of lean training programs on clinical outcomes, resource utilization, and overall organizational effectiveness.

Table (1): Distribution of the First Line Nurse Managers (HNs) according to their demographic, and work-related characteristics:

Demographic data	Frequency (N=60)	Percent
Age		
▪ <25	1	1.7
▪ 25 - <35	10	16.7
▪ 35 - <45	32	53.3
▪ >45	17	28.3
Work Unit		
▪ Burn unit	2	3.3
▪ Dialysis	3	5.0
▪ Ear nose and throat unit (ENT)	2	3.3
▪ Emergency unit	4	6.7
▪ Endoscopy unit	2	3.3
▪ Hematemesis unit	2	3.3
▪ Intensive Care Units	8	13.3
▪ Medical care unit	4	6.7
▪ Neonatal care unit (NCU)	2	3.3
▪ Obstetrics and Gynecology unit	3	5.0
▪ Operative unit	5	8.3
▪ Ophthalmology	1	1.7
▪ Outpatient care unit	4	6.7
▪ Pediatric care unit (PCU)	2	3.3
▪ Pediatric intensive care unit (PICU)	2	3.3
▪ Physical therapy unit	1	1.7
▪ Sterilization unit	2	3.3
▪ Surgical care units	7	11.7
▪ Toxicology unit	2	3.3
▪ Urology unit	2	3.3
Gender		
▪ Male	0	0.0
▪ Female	60	100.0
Level of education		
▪ Bachelor of Nursing	42	70.0
▪ Post Graduate Diploma degree	7	11.7
▪ Master's degree	11	18.3
Years of experience in nursing		
▪ 1- <5	4	6.7
▪ 5-10	12	20.0
▪ 10-15	10	16.7
▪ 15-20	20	33.3
▪ >20	14	23.3
Experience as HN		
▪ 1- <5	15	25.0
▪ 5-10	18	30.0
▪ 10-15	5	8.3
▪ 15-20	11	18.3
▪ >20	11	18.3
Do you have any training or certification on quality		
▪ No	49	81.7
▪ Yes	11	18.3
If the answer is yes, mention a name training or certification		
▪ TQM Course	4	36.4
▪ training in quality	7	63.6
Do you join any process improvement program?		
▪ No	56	93.3
▪ Yes	4	6.7

Table (2): Distribution of the Nurses according to their demographic, and work-related characteristics:

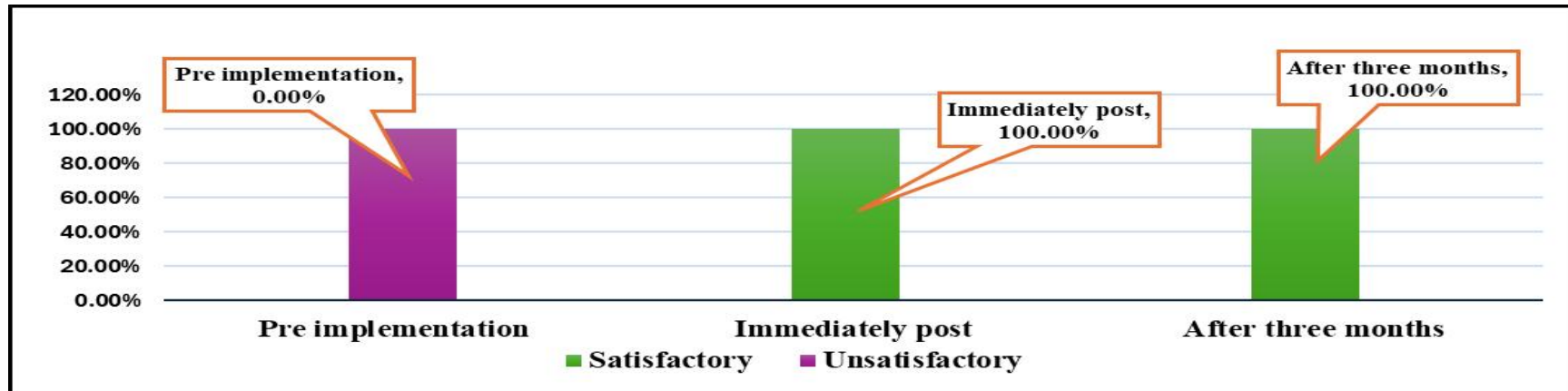
Demographic data	Frequency (N=250)	Percent
Age		
▪ <25	42	16.8
▪ 25 - <35	79	31.6
▪ 35 - <45	66	26.4
▪ >45	63	25.2
Qualification		
▪ Diploma of Secondary Nursing School	97	38.8
▪ Diploma of Technical Institute of Nursing	80	32.0
▪ Bachelor degree of Nursing Sciences	69	27.6
▪ Post graduate degree	4	1.6
Work unit		
▪ Hematemesis unit	8	3.2
▪ Burn unit	8	3.2
▪ Dialysis unit	15	6.0
▪ Ear nose and throat unit (ENT)	6	2.4
▪ Emergency unit	15	6.0
▪ Endoscopy unit	6	2.4
▪ Intensive Care Unit	42	16.8
▪ Medical care unit	15	6.0
▪ Neonatal care unit	11	4.4
▪ Obstetrics and gynecology unit	15	6.0
▪ Operative unit	15	6.0
▪ Ophthalmology unit	6	2.4
▪ Outpatient unit	20	8.0
▪ Pediatric care unit	10	4.0
▪ Pediatric intensive care unit	10	4.0
▪ Sterilization unit	5	2.0
▪ Surgical care unit	25	10.0
▪ Toxicology	10	4.0
▪ Urology unit	8	3.2
Years of experience in work unit		
▪ 1 - <5	138	55.2
▪ 5 - <10	31	12.4
▪ 10 - <15	34	13.6
▪ 15 - <20	25	10.0
▪ >=20	22	8.8
Years of experience in hospital		
▪ 1 - <5	73	29.2
▪ 5 - <10	48	19.2
▪ 10 - <15	37	14.8
▪ 15 - <20	38	15.2
▪ >=20	54	21.6
Years of experience since graduation		
▪ 1 - <5	49	19.6
▪ 5 - <10	50	20.0
▪ 10 - <15	40	16.0
▪ 15 - <20	37	14.8
▪ >=20	74	29.6
Have you received any quality training		
▪ Yes	22	8.8
▪ No	228	91.2
Have participated improvement projects		
▪ Yes	1	0.4
▪ No	249	99.6

Table (3): Differences between mean scores HNs over all Lean Knowledge level and Readiness level for Lean Transformation through the program phases:

variables	pre	Immediately post	After months 3	T1 (P)	T2 (P)	T3 (P)	F (P)	ETA Square
	Mean ± SD.	Mean ± SD.	Mean ± SD.					
Overall HNs' Lean knowledge	8.73±4.20	38.18±1.70	36.90±7.10	55.003(0.000)*	24.665(0.000)*	1.367(0.177)	672.418(0.000)*	0.919
Valence	21.97±3.30	26.27±3.73	25.50±5.80	7.072(0.000)*	4.681(0.000)*	1.152(0.254)	22.829(0.000)*	0.279
Efficacy	22.85±3.07	29.15±3.17	28.08±6.13	12.196(0.000)*	6.419(0.000)*	1.431(0.158)	45.883(0.000)*	0.437
Discrepancy	20.72±3.22	24.87±3.22	24.23±5.34	8.142(0.000)*	4.917(0.000)*	0.960(0.341)	24.860(0.000)*	0.296
Appropriateness	20.53±3.32	24.27±3.26	23.43±5.39	7.140(0.000)*	4.123(0.000)*	1.265(0.211)	19.168(0.000)*	0.245
Principal Support	22.08±3.33	25.25±3.46	24.92±5.75	6.401(0.000)*	3.582(0.001)*	0.545(0.588)	14.596(0.000)*	0.198
Overall HNs' Lean Readiness	108.15±13.20	129.80±14.39	126.17±27.34	10.193(0.000)*	5.209(0.000)*	1.106(0.273)	29.578(0.000)*	0.334

T1: Paired Samples Test between Pre and Post
 T2: Paired Samples Test between Pre and After 3 months
 T3: Paired Samples Test between Post and After 3 months
 F: Repeated Measure ANOVA
 *p<0.05

Figure (1):



Percentage of HNs' overall Lean knowledge level through the program phases

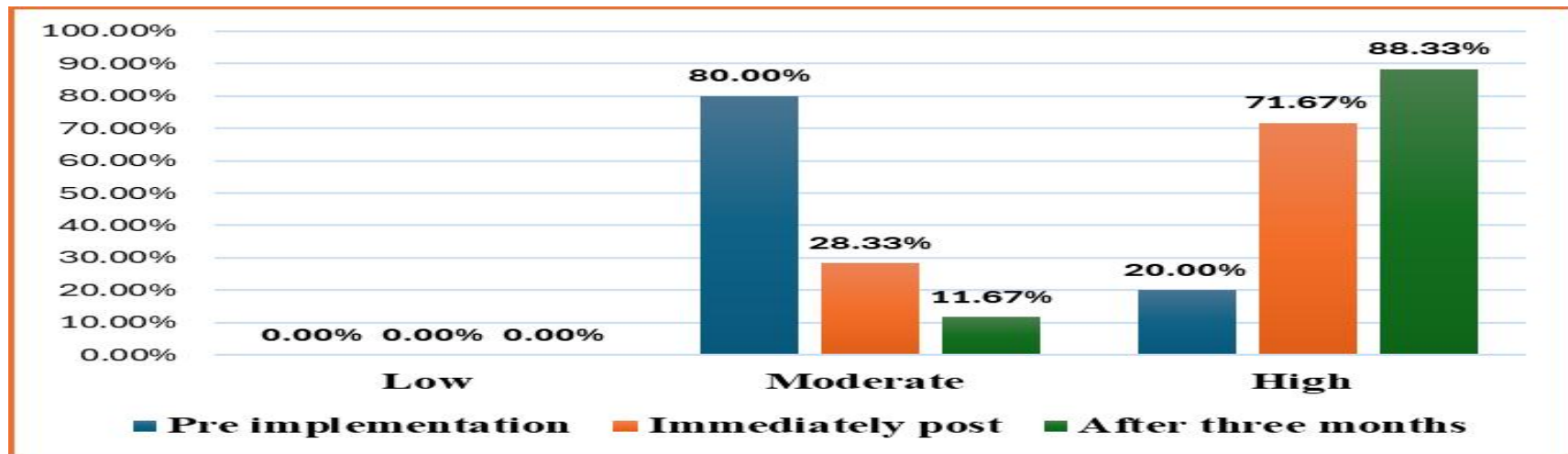


Figure (2): Percentage of HNs' overall Lean Readiness level through the program phases

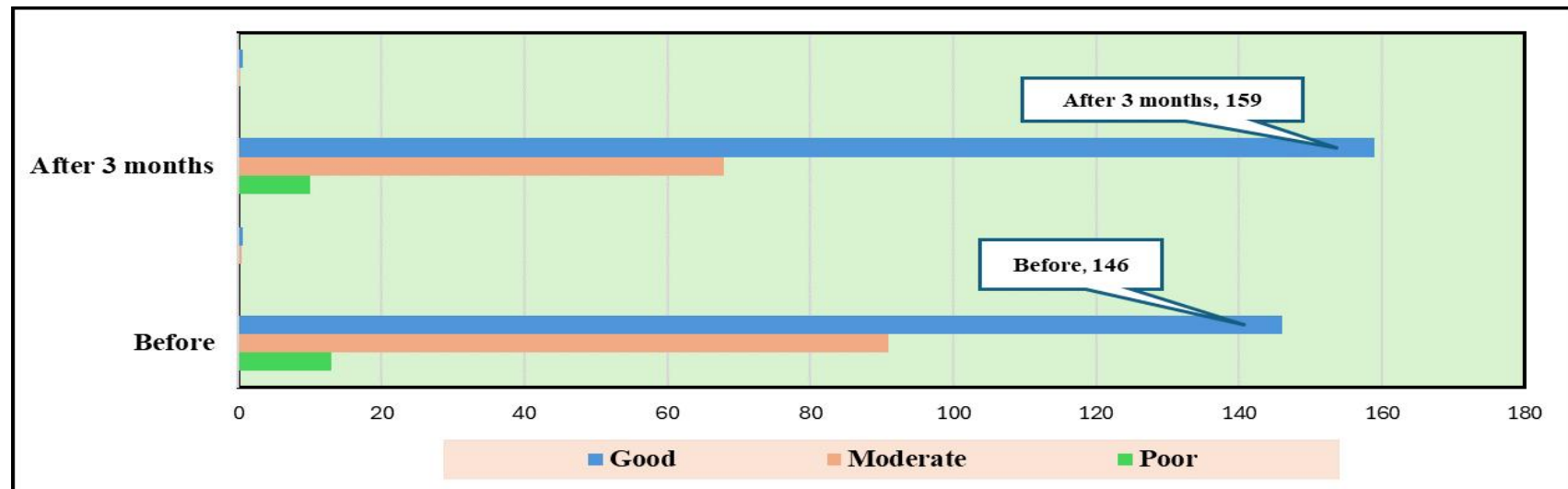


Figure (3): Percentage of Nurses' perception level of lean culture dimensions before and after 3 months from Lean Training Program implementation

Table (4): Differences between mean scores Nurses' perception of Lean Culture before and after 3 months from Lean Training Program implementation.

Dimensions	Pre	After three months	Differences	T (P)
	Mean ± SD.	Mean ± SD.	Mean ± SD.	
Continuous improvement	61.48±10.54	63.38±10.83	1.90±14.82	2.028(0.044)*
Process focused	34.51±7.44	37.59±7.50	3.08±10.43	4.668(0.000)*
Mutual respect and trust	29.64±5.87	30.87±5.60	1.23±8.04	2.424(0.016)*
Staffs Involvement	59.93±12.83	63.80±13.88	3.87±18.53	3.300(0.001)*
Consistency	49.24±9.93	51.64±9.82	2.40±13.75	2.765(0.006)*
Mission	24.94±5.60	27.07±4.78	2.13±7.07	4.758(0.000)*
Adaptability	27.33±6.54	29.88±5.67	2.55±8.36	4.827(0.000)*
Overall Lean Culture	287.08±53.17	304.24±52.36	17.16±72.58	3.739(0.000)*

T: Paired Samples Test *p<0.05

Table (5): Correlation Matrix between HNs overall Lean Knowledge level, Readiness level for Lean Transformation and Lean Culture Pre lean Training Program implementation

Pre-Training Program		Overall HNs' Lean knowledge	Valence	Efficacy	Discrepancy	Appropriateness	Principal Support	Overall HNs' Lean Readiness	Continuous improvement	Process focused	Mutual respect and trust	Staffs Involvement	Consistency	Mission	Adaptability	Overall Lean Culture
Overall HNs' Lean knowledge	r															
	P															
Valence	r	0.313*														
	P	0.000*														
Efficacy	r	0.147*	0.894*													
	P	0.020*	0.000*													
Discrepancy	r	-0.100	0.777*	0.862*												
	P	0.114	0.000*	0.000*												
Appropriateness	r	-0.051	0.779*	0.869*	0.934*											
	P	0.422	0.000*	0.000*	0.000*											
Principal Support	r	-0.488*	0.240*	0.481*	0.697*	0.641*										
	P	0.000*	0.000*	0.000*	0.000*	0.000*										
Overall HNs' Lean Readiness	r	0.006	0.875*	0.944*	0.968*	0.958*	0.642*									
	P	0.927	0.000*	0.000*	0.000*	0.000*	0.000*									
Continuous improvement	r	0.257*	0.095	0.069	-0.046	-0.048	-0.106	0.002								
	P	0.000*	0.134	0.280	0.468	0.454	0.093	0.977								
Process focused	r	0.091	0.000	0.007	-0.075	-0.073	-0.031	-0.039	0.716*							
	P	0.151	0.998	0.912	0.239	0.252	0.624	0.540	0.000*							
Mutual respect and trust	r	0.119	0.067	0.087	-0.018	-0.026	-0.006	0.025	0.801*	0.765*						
	P	0.061	0.293	0.169	0.782	0.688	0.925	0.692	0.000*	0.000*						
Staffs Involvement	r	0.116	0.031	0.047	-0.033	-0.036	-0.008	0.000	0.704*	0.817*	0.747*					
	P	0.067	0.626	0.456	0.604	0.570	0.901	0.995	0.000*	0.000*	0.000*					
Consistency	r	0.124*	0.027	0.035	-0.059	-0.068	-0.048	-0.023	0.717*	0.827*	0.775*	0.930*				
	P	0.049*	0.673	0.585	0.356	0.281	0.447	0.714	0.000*	0.000*	0.000*	0.000*				
Mission	r	0.107	-0.008	-0.009	-0.054	-0.095	-0.029	-0.043	0.645*	0.719*	0.701*	0.861*	0.882*			
	P	0.091	0.902	0.892	0.396	0.133	0.646	0.494	0.000*	0.000*	0.000*	0.000*	0.000*			
Adaptability	r	0.116	0.009	-0.005	-0.059	-0.085	-0.030	-0.037	0.690*	0.777*	0.707*	0.846*	0.877*	0.906*		
	P	0.067	0.891	0.939	0.355	0.180	0.634	0.560	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*		
Overall Lean Culture	r	0.154*	0.039	0.041	-0.053	-0.064	-0.044	-0.016	0.844*	0.889*	0.862*	0.946*	0.955*	0.895*	0.910*	
	P	0.015*	0.540	0.522	0.401	0.310	0.490	0.805	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	

Correlation is significant at the 0.05 level (2-tailed).

Correlation Coefficient (R)	+/-1.0	+/-0.8 to 1.0	+/- 0.6 to 0.8	+/-0.4 to 0.6	+/-0.2 to 0.4	0.0 to +/-0.2
Description	Perfect relation	Very strong relation	strong relation	Moderate relation	Weak relation	Very Weak or no relation

Table (6): Correlation Matrix between HNs overall Lean Knowledge level, Readiness for Lean Transformation level, and Lean Culture Post 3 months from lean Training Program implementation

Post 3 months Training Program		Overall HNs' Lean knowledge	Valence	Efficacy	Discrepancy	Appropriateness	Principal Support	Overall HNs' Lean Readiness	Continuous improvement	Process focused	Mutual respect and trust	Staffs Involvement	Consistency	Mission	Adaptability	Overall Lean Culture
Overall HNs' Lean knowledge	r															
	P															
Valence	r	0.420*														
	P	0.000*														
Efficacy	r	0.298*	0.720*													
	P	0.000*	0.000*													
Discrepancy	r	0.352*	0.851*	0.781*												
	P	0.000*	0.000*	0.000*												
Appropriateness	r	0.406*	0.853*	0.701*	0.903*											
	P	0.000*	0.000*	0.000*	0.000*											
Principal Support	r	0.141*	0.595*	0.762*	0.702*	0.789*										
	P	0.025*	0.000*	0.000*	0.000*	0.000*										
Overall HNs' Lean Readiness	r	0.352*	0.883*	0.876*	0.939*	0.944*	0.864*									
	P	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*									
Continuous improvement	r	-0.075	-0.072	-0.019	-0.024	-0.056	-0.082	-0.056								
	P	0.240	0.260	0.763	0.711	0.381	0.194	0.374								
Process focused	r	-0.094	-0.033	-0.013	0.014	-0.027	-0.042	-0.022	0.875*							
	P	0.138	0.607	0.837	0.831	0.675	0.511	0.726	0.000*							
Mutual respect and trust	r	-0.089	-0.030	-0.001	-0.002	-0.035	-0.063	-0.030	0.837*	0.874*						
	P	0.159	0.640	0.990	0.969	0.583	0.323	0.636	0.000*	0.000*						
Staff Involvement	r	0.133*	-0.030	0.015	0.027	-0.034	-0.042	-0.014	0.720*	0.790*	0.732*					
	P	0.036*	0.642	0.813	0.666	0.596	0.507	0.822	0.000*	0.000*	0.000*					
Consistency	r	-0.095	-0.012	0.009	0.014	-0.033	-0.051	-0.017	0.723*	0.796*	0.772*	0.914*				
	P	0.135	0.853	0.892	0.821	0.603	0.419	0.785	0.000*	0.000*	0.000*	0.000*				
Mission	r	-0.095	-0.044	-0.014	-0.031	-0.057	-0.061	-0.047	0.713*	0.755*	0.725*	0.819*	0.900*			
	P	0.136	0.484	0.825	0.628	0.373	0.338	0.462	0.000*	0.000*	0.000*	0.000*	0.000*			
Adaptability	r	-0.004	0.050	0.037	0.011	-0.003	-0.039	0.010	0.618*	0.668*	0.656*	0.687*	0.801*	0.834*		
	P	0.953	0.432	0.559	0.858	0.956	0.543	0.881	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*		
Overall Lean Culture	r	-0.100	-0.031	0.002	0.005	-0.040	-0.060	-0.028	0.880*	0.917*	0.881*	0.926*	0.945*	0.900*	0.810*	
	P	0.113	0.622	0.970	0.935	0.532	0.342	0.656	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	

Table (7): Mean percent score of HNs evaluation of the lean Training Program immediately post the program implemented.

variable	N	Mean	Std. Deviation	Skewness	Kurtosis	Mean score percent
		Statistic	Statistic	Statistic	Statistic	
Objectives of the lean training program	3	13.55	1.40	-0.65	0.09	90.33%
Content of the program	7	33.13	2.17	-1.01	0.19	94.67%
The educational climate	4	18.20	1.96	-0.84	0.37	91.00%
The instructional materials and methods	7	33.33	2.67	-1.37	0.22	95.24%
The trainer effectiveness	4	19.27	1.51	-1.71	1.06	96.33%
overall training program evaluation	25	117.48	7.39	-1.42	1.80	93.99%

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