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Effectiveness of Mobile Application Use on the Compliance & Behavior of Soft Contact Lens Wearers in the Occupied Palestinian Territories

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Thesis Approval

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Dedication

I would like to dedicate this work; to my lovely husband Khalid who supported me all the way in my Master's degree journey.

Declaration

This thesis was submitted in partial fulfillment of the requirements for the Master's degree in Health Informatics.

I declare that the content of this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Areen Mohammad Shalabi

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Date: 21 / 6/ 2022

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Abstract

Background

Contact lens compliance is the adherence of contact lens wearers with the recommendations and instructions provided by eye care practitioners. Contact lenses wearers who exhibit poor compliance behavior with contact lens care and wear instructions are more likely to have ocular complications. Current strategies to enhance contact lens compliance behavior are limited. The standard method is patient education either verbally, or through written instructions that are reinforced with photos, or videos, or booklets. Generally, one of the strategies that is used to enhance patients' compliance in health sector is mHealth apps. mHealth apps have been utilized to ensure continuity of care, and change poor health behaviors, it is worth to assess its effectiveness in improving compliance of contact lens wearers.

Objective

To assess the effectiveness of mHealth app (LENSA) in improving compliance and healthy behaviors among soft contact lens wearers in the Occupied Palestinian Territories.

Methodology

A quasi- experiment design that use pre-/ post-intervention and a comparable control group was utilized. The data collection was conducted using a questionnaire that was designed to assess the level of compliance on both the intervention group and the control group. The intervention group was trained on the use of mHealth app LENSA, and received written instruction on the care and wear of contact lenses, while the control group received only verbal instructions. The level of compliance for the intervention and control groups were measured and compared at the end of the study to evaluate the effect of the intervention.

Results

A total of 201 participants completed the study. One hundred and four participants (104) were enrolled in the intervention group, while ninety-seven participants (97) were in the control group. The mean age of participants was 27.4 ± 7.38 years, and 91.5% of them were females, and 48.3% of participants held bachelor degree. There was a statistically significant increase in the compliance scores in fourteen out of twenty lens care behaviors for the intervention group, and in eight out of twenty lens care behaviors for the control group (Wilcoxon Signed Ranks Test, $p<0.05$). LENSA app was effective in improving only one lens care behavior "daily wearing time of contact lenses'' (Mann Whitney U Test, p-value=0.03). The average level of compliance for both groups post-intervention was 80.6%, compared to 45.3% compliance level pre-intervention.

Conclusion

Although there was no difference between the instructions delivered through enhancement strategy/written instruction and the standard verbal instructions, LENSA app confirmed its effectiveness in controlling daily wearing hours with a significant difference between the intervention and the control group, in addition to the improvement in the compliance of other behaviors despite their non- significance. Further studies are needed to assess the effectiveness of mHealth app for longer periods of time, using a large sample size and other types of contact lenses.

Keywords:

Hand Hygiene, risk factors, mobile applications, contact lens, health behavior, compliance, optometric practice.

Table of Contents

List of Tables

List of Figures

List of Abbreviation

No	Abbreviation	Meaning
1	oPt	The occupied Palestinian territories
2	WHO	World Health Organization
3	mHealth app	Mobile health application
4	CDC	Center for Disease Control and prevention
5	AOA	American Optometric Association
6	MRRF	Manufacturer Recommended Replacement Frequency
7	GDM	Gestational Diabetes Mellitus
8	HIS	Health Information System
9	GPS	Global Positioning System

Chapter One: Introduction

1.1 Background

Contact lenses are a convenient alternative management solution to spectacles and are applied to the cornea to primarily correct refractive errors (with prescription), in addition to their indication for cosmetic that manufactured either colored (without prescription) or corrective with color (with prescription) and for therapeutic purposes. (Gyawali et al., 2014; Ţălu et al., 2011; Taslipinar Uzel et al., 2018) The prevalence of contact lens wearers is continuously increasing rapidly, and there are approximately 175 million contact lens wearers worldwide.(Akerman, 2018; Lim et al., 2018; Stapleton et al., 2007; Thite et al., 2021) Studies reported that about 30%-50% of contact lens wearers developed contact lens related ocular complications(Forister et al., 2009), and these complications vary from mild discomfort to severe sight threatening microbial keratitis which may lead to vision loss.(Keay et al., 2006; Naroo, 2012)These complications are reported to be more common for patients who exhibit poor compliance behavior with contact lens care and wear instructions. The identified risk factors associated with ocular complications were classified into non-modifiable risk factors such as age, gender, and socioeconomic status, and modifiable risk factors, which are mainly related to contact lens compliance behaviors such as poor hand hygiene, improper contact lens care, and over wear of contact lenses. (Dart et al., 2008a; Gyawali et al., 2014; Morgan et al., 2011a; Stapleton et al., 2007, 2008; Y. Wu, Carnt, & Stapleton, 2010)

Noncompliance is a critical clinical issue in health care, the rate of which varies according to the type of treatment or intervention provided.(Dumbleton et al., 2013) In contact lens practice, compliance is defined as adherence of contact lens wearers with the recommendations and instructions provided by eye care practitioners or written manufacturer instructions regarding lens

wear and care.(Bakkar & Alzghoul, 2020; Philip Morgan, 2008; Sapkota, 2015; Y. T. Y. Wu et al., 2015) High level of compliance is achieved when contact lens wearers fully adhere with healthy and adequate behaviors to avoid complications. Current strategies to enhance contact lens compliance are limited. The gold standard method is patient education that every eye care practitioner is trained to implement, either verbally or through written instructions. This method is highly variable among practitioners and sometimes ambiguous. Practitioners should provide proper education and explanation for all contact lens care regimen, and the consequences imposed by noncompliance behavior. (Sapkota, 2015) Furthermore, regular after care visits are recommended for repetition of instructions to ensure full understanding and compliance of patients. Nevertheless, verbal and written instructions may not be enough to encourage and engage contact lens wearers in compliance behavior, thus using videos, photographs, booklets, posters and checklists have been used in combination with standard instructions to improve compliance.(McMonnies, 2011b, 2011a)

Information technology techniques have been utilized in health care in various ways to improve the quality and safety of health services, simplifying access to care system, reducing costs, and allowing health care to be affordable to everyone anywhere.(A Survey of Mobile Phone usage by Health professionals in the UK, 2010; Øvretveit et al., 2007)The number of mobile users worldwide is 6.75 billion and forecasting to reach 7.33 billion in 2023. (S. O'Dea, 2021) During COVID pandemic the use of technology to perform administrational work in health care, in education and in managerial jobs was widely introduced. In contact lens practice, video call appointments were used to ensure continuity of care for contact lens wearers through hearing the symptoms of patients and scheduling a face-to-face appointment according to the urgency of cases.(Naroo et al., 2021)

In 2020, 87 million people in the US used a health or fitness app monthly. (Remy Franklin, 2021) The World Health Organization (WHO) defines Mobile health applications (mHealth apps) as the use of mobile devices including smartphones, patient monitoring devices, personal digital assistance, and other wireless devices (e.g. wearable devices) for the purpose of providing medical and public health services. (WHO Global Observatory for eHealth., 2011)mHealth apps mainly aim to adopt applications that promote healthy lifestyle such as: nutrition, weight control, physical activity, blood glucose control, smoking cessation and cardiovascular disease care.(Overdijkink et al., 2018) The benefits of mHealth apps includes insuring continuity of care, providing medical services to anyone, anywhere and anytime, enhancing patient provider communications, in addition to providing medical interventions and allowing patients' engagement in promoting health outcomes and changing health behaviors.(Boudreaux et al., 2014; Efron, 1997)

Contact Lens compliance behaviors were extensively studied and reported in literature. Examples of these behaviors include contact lens wear time, hand hygiene, lens and storage case disinfection, water exposure, lens replacement schedule and after care visits. (Claydon & Efron, 1994b; Efron, 1997) The level of compliance with these behaviors among contact lens wearers varies, and this is attributed to unawareness of associated complications related to poor compliance with healthy contact lens wear behaviors, difficulty in adhering to optimal cleaning regimen, and the variable and ambiguous nature of practitioners' recommendations.(Robertson & Cavanagh, 2011) The literature estimates the rate of noncompliance among contact lens wearers to be between 40-91% worldwide.(Gyawali et al., 2014; Y. Wu, Carnt, & Stapleton, 2010) The variation in non-compliance rate is related to the country where the study is conducted, the type of lenses studied and the modality of contact lenses.(Bhandari, 2012) Several studies investigated various strategies to improve compliance among contact lens wearers including using written instructions reinforced

by photos, posters and videos rather than just verbal instructions, and sending exercises related to contact lens proper handling and care by email. In addition to providing simple written instructions online to those whom English is not their native language. Patient's non-compliance is considered common and critical within the health care sector, and thus one of the strategies that is used to enhance patients' compliance is mHealth apps which provide either single function tools such as education only, or multiple function tools such as education, reminders, entering data and providing feedback. Multiple studies reported that there was a positive change and improvement in compliance among patients who utilized mHealth apps particularly in disciplines of physical activity, diet, and adherence to medications or therapy.(Borgen et al., 2019; Glynn et al., 2014; Han & Lee, 2018)

1.2 Significance & Knowledge Gap

Poor compliance behaviors among contact lens wearers can lead to irreversible sight threatening complications. These complications were mostly associated with modifiable behaviors that can be improved simply through providing strategies that support healthy behaviors by eye care practitioners. Smartphones or mobiles have become a personal necessity that can be utilized in healthcare to remind users of appointments, daily drug doses, and promote healthy behaviors. A few mHealth apps related to contact lenses are available. The aim of this study was to assess the effectiveness of LENSA, a Palestinian designed contact lens mHealth app, in improving compliance and healthy behaviors among contact lens wearers. To date, no studies in Palestine were conducted to estimate the prevalence of contact lens wearers, who wear either cosmetic contact lenses or corrective contact lenses of various types. In addition, there remains to be lack of information regarding the number of those who purchase contact lenses online in the country. Furthermore, no studies in Palestine were found in literature that investigated the effectiveness of

mHealth apps on improving the compliance and behavior of soft contact lens wearers. The results of this study will highlight the importance of using health technology to enhance compliance among contact lens wearers, and will ultimately provide information that can assess the effectiveness of health informatics in different domains.

1.3 Study Hypothesis

The main research null hypothesis assumes that there is no relationship between using of contact lens mHealth apps and improving the Palestinian contact lens wearer behavior and compliance of contact lens care.

The other hypothesis:

1- There is no correlation between the level of compliance and the demographic data (age, gender and level of education).
2- There is no correlation between the level of compliance and the participants contact lens history.

1.4 Study Objectives

1.4.1 Primary Objective

To evaluate the effectiveness of mHealth apps (LENSA app) on the behavior and compliance of contact lens wearers in oPt, through comparing their compliance level before and after mHealth apps usage.

1.4.2 Secondary Objectives

1- Describe the demographical profile of contact lens wearers in the oPt..
2- Describe the contact lens wearing history among contact lens wearers in the oPt.

3- Determine the level of compliance among contact lens wearers who replaced their contact lenses (biweekly, monthly, quarterly and yearly).
4- Compare the effectiveness of mHealth apps & written instructions versus verbal instructions in improving compliance.
5- Assess the awareness of Palestinian soft contact lens wearers in the significance of aftercare visits
6- Assesses the relation between the level of compliance and modifiable and non-modifiable risk factors.
7- Identify the lens care procedure that have the highest & lowest compliance.

1.5 Research Questions

The main research question is: "Are mhealth apps (LENSA) effective to improve the compliance and behavior of contact lens wearers in the oPt?".

The other specific research questions are directly related to the variables that influence the level of compliance:

1- What is the level of compliance for both groups pre and post intervention?
2- What is the demographic profile of soft contact lens wearers?
3- What is the compliance level of aftercare visits? And Do Palestinian contact lens wearers aware about their aftercare visits?
4- What is the relation between level of compliance and demographical variables?
5- What is the relation between level of compliance and contact lens wearing history?
6- What is the behavior that is related to the highest/lowest compliance in the wearing and replacement habits category?

7- What is the procedure that has the highest/ lowest compliance in the disinfection procedures category?

8- What is the procedure that has the highest/ lowest compliance in the care of contact lens accessories category?

Chapter Two: Literature Review

2.1 Introduction

This chapter reviewed studies and publications related to the contact lens wearers compliance, enhancement strategies, and mHealth apps effectiveness, and it was classified as follows: Contact lenses compliance universally, demographic profile of contact lens wearers, ocular complications related to non-compliance, contact lens wearer behaviors, strategies to enhance contact lens wear compliance, and mobile health applications and its effectiveness in changing health behavior.

2.2 Contact Lenses Compliance Universally

The reported rate of compliance varies among countries mainly due to different study designs among published studies. This variation has mainly been attributed to the method of assessing compliance, which relies mainly on self-administrated questionnaires, where some studies assess rate of compliance through contact lens wearer demonstrating the frequency of practicing each care behavior, while other studies ask subjective questions using yes or no answers that sometimes are not specific about lens care procedures. (Noushad et al., 2012; Pradhan et al., 2017)

An overall non-compliance rate ranging from 40-91% has been reported in literature.(Gyawali et al., 2014; Philip Morgan, 2008; Robertson & Cavanagh, 2011) In Asia, non-compliance to contact lens wear was reported to be 66% in India(Noushad et al., 2012), 93% in Hong Kong(A. M. S. Yung et al., 2007), 89.9% in Japan, 84.3% in China and 67.4% in Russia.(Morgan et al., 2011a) In USA, non-compliance was reported to be 99.6% in Texas, 91.1% in overall USA, and 76.6% in Canada. In Europe, it was 82% in Germany, 79.4% in Spain, 90.2% in UK and 81.1% in Italy. In Australia, non-compliance rate was 81.4%.(Morgan et al., 2011a) In Africa, a study conducted in Namibia to assess the prevalence of non-compliance with replacement schedule, and

the results was 41.5%.(Shamiso G. GWATA, 2017) Contributing factors to high rates of non-compliance include unawareness of compliance behavior and its associated complication, difficulty in adhering to optimal cleaning regimen, and the variable and ambiguous nature of practitioner's recommendations.(Gyawali et al., 2014; Philip Morgan, 2008)

2.3 Demographic Profile of Contact Lens Wearers and Compliance

The demographical factors that were found to be correlated with non-compliance rate include gender, age, and socioeconomic class. Most studies report contact lens wear to be more common among females. Morgan P. et al in their international analysis for contact lens wearers compliance in 14 countries, stated that gender was a predictive factor for non-compliant behaviors with better compliance reported for females compared to males. (Morgan et al., 2011a) Non-compliance of contact lens care behavior was reported to be more common among users at collage age of 15-25 years, this related to lack of family supervision or unavailability of money to purchase new lenses and care supplies for those who live alone. In addition to, unawareness of risks associated with non-compliance behaviors. (Chalmers et al., 2011)People of high socioeconomic class are more able to handle expenses associated with contact lens fitting, lenses products and accessories. In addition, they are more committed with after care visits, therefore they were more aware of contact lens cleaning procedures and thus more likely to exhibit compliance behavior than those of low socioeconomically class. Education level and contact lens type were not found to have a significant effect on compliance rate.(Janti et al., 2014; Kumar Chattu, 2013)

2.4 Ocular Complications Related to Non-Compliance

Poor compliance regarding contact lens wear and care behaviors can lead to ocular complications, such as dryness and discomfort, which ultimately leads to reduction in wear time. In certain cases,

poor compliance can lead to microbial keratitis, a rare but potentially severe complication of contact lens wear, which is associated with significant morbidity including visual loss, financial costs and painful symptoms. (Naroo, 2012; Stapleton et al., 2008, 2021)

The identified risk factors associated with the incidence of microbial keratitis are classified into modifiable risk factors and non-modifiable risk factors. Modifiable risk factors included extended wear, hand and case hygiene, smoking, and online purchase of contact lenses. Non-modifiable risk factors include gender, age and refractive error. (Naroo, 2012; Stapleton et al., 2008, 2021). *Extended wear* which include over wear of contact lenses per week and overnight use, was found to be with a greater risk of microbial keratitis regardless of contact lens material.(Dart et al., 2008b; Stapleton et al., 2008, 2021)*Contaminated cases* was extensively studied in literature and was found to be associated with high risk of developing microbial keratitis particularly due to acanthamoeba and bacteria.(Brown et al., 2018; Carnt et al., 2018; Stapleton et al., 2021)

Smokers were reported to have keratitis 3 times more than non-smokers, which may be linked to a general lack of hygiene with respect to behaviors relating to contact lens wear and care. In Palestine, it was reported that the prevalence of male smokers is 52.7%, and 16.5% among females, and to date no studies were conducted to assess the prevalence of the smoking contact lens wearers. (Dart et al., 2008b; Lam et al., 2002; Morgan et al., 2011b; Musmar, 2012; *Schein1989*, n.d.; Stapleton et al., 2008) *Online supply of contact lenses,* the availability of several options of contact lens products, special offers and discounts, and convenience were reported to be the top three reasons why contact lens users purchase through online websites. Those who buy contact lens through unauthorized sources, are likely not receiving with accurate instructions regarding lens care and wear behaviors, and they are more likely to be non-compliant with aftercare visits or

with proper care and hygiene, which ultimately increasing their risk of developing microbial keratitis.(Stapleton et al., 2008; Stapleton & Carnt, 2012; Y. Wu, Carnt, & Stapleton, 2010)

As for non-modifiable risk factors, studies reported that *males* tend to have microbial keratitis more than females, and that it may be related to contact lens hygienic behaviors. (Dart et al., 2008b; Lim et al., 2016; Stapleton et al., 2021) Contact lens wearers in the *age group* of 25-40 years may have microbial keratitis related to contact lenses more than other age groups, and this was thought to be related to not adhering strictly with contact lens care and wear recommendations, or due to the fact that this age group included contact lens wearers who work in agriculture and may have developed fungal keratitis due to poor hygiene.(Brown et al., 2018; Carnt et al., 2018; Dart et al., 2008b; Lam et al., 2002; Stapleton et al., 2008, 2021; Ting et al., 2021) Finally, studies reported that *hyperopia* is one of the risk factors associated with developing microbial keratitis, but no reasoning was provided to explain this association.(Dart et al., 2008b; Stapleton et al., 2008; Stapleton & Carnt, 2012)

2.5 Contact Lens Wearer Behaviors That Influence Compliance Rate

Centers for Disease Control and Prevention (CDC)(CDC, 2020b), and American Optometric Association (AOA)(AOA, 2019b) provides recommendations of healthy wearing, cleaning behaviors and habits for wearing contact lens safely. Poor adherence to these recommendations were considered to influence the level of compliance. The most common reasons cited for not following these recommendation include saving money and forgetting replacement recommended schedule.(Kelsy Steele, 2018) The factors that influence contact lens compliance rate include over wear of contact lens, non-adherence to manufacturers' recommended replacement frequency (MRRF), hands hygiene, contact lens disinfection procedures, care of contact lens accessories, exposure to water and saliva and after care visits.

Over-Wear

Overnight wear and napping in contact lenses are risky behaviors that cause several complications. A 25% of contact lens wearers were sleeping overnight while wearing lenses, and they are at high risk of having corneal infiltrative events and microbial keratitis.(Jansen et al., 2011) A study conducted in Jordan reported that sleeping and napping non-compliance rate was 4.3% which is good, and this related to the fact of attending participants to the university clinic that provides written instructions and posters of contact lens handling and care.(Bakkar & Alzghoul, 2020)

Another study conducted on the university students in India revealed that 23% of wearers napped in contact lens, while 5.6% were sleeping overnight while wearing their contact lenses. This was attributed to the fact that practitioners are not stressing on the risk of sleeping overnight or sleeping short period with contact lenses.(Noushad et al., 2012) Another study reported that 25.2% CL wearers slept over-night and the authors attributed that to the absence of instructions related to over wear given by practitioners.(Pradhan et al., 2017)

Manufacturers' Recommended Replacement Frequency (MRRF).

One of the most common causes of ocular complications is non- compliance with the MRRF, resulting in over wear of contact lenses and ultimately increases the amount of deposits on the lens. The MRRF varies between different types of contact lenses and depends on the type of contact lens and its manufacturing materials. Replacement schedule can be daily (contact lens discarded everyday), bi-weekly (contact lens discarded every two weeks), monthly (contact lens discarded every month), quarterly (contact lens discarded every 3 months) or annual replacement (contact lens discarded every year). The least compliance with MRRF found to be more in contact lens wearers using bi-weekly and monthly replacement schedule.(Dumbleton et al., 2013;

Hickson-Curran et al., 2011; Yeung et al., 2010a) Dumbelton K. et.al. reported the most common reasons of low compliance with MRRF that some patients forget the replacement date, or to save money, and other patients thought it's not harm to wear it longer.(Dumbleton et al., 2013)

Hands Hygiene

Human hands are in contact with countless microorganisms that are easily transmitted to eyes, contact lenses and contact lens accessories if not washed sufficiently. Therefore, poor hand hygiene had an effect on case contamination, and increased bacterial bio-burden. The awareness of contact lens wearers with hand hygiene compliance before inserting and removal of contact lens is relatively high among several studies, with an average 59% to 89%.(Morgan et al., 2011a; Noushad et al., 2012; Pradhan et al., 2017; A. M. S. Yung et al., 2007) This high compliance was attributed to the fact that eye practitioners out a lot of emphasis on this issue at every patient visit. Another study reported compliance rate as high as 92% without specifying the method of hand washing (soap or water). This compliance rate dropped to 76% when participants were questioned if they used soap as a disinfecting agent for hand washing.(Noushad et al., 2012) The range of hand hygiene noncompliance was reported to be between 14-50%, whether with using only water or soap.(Gyawali et al., 2014; Noushad et al., 2012)

Contact Lenses Disinfection Procedures

In three studies the rate of non-compliance with contact lens rinsing and rubbing disinfection techniques were reported to be 48% among Indian university students(Noushad et al., 2012), 44.3 % among Jordanian university students(Bakkar & Alzghoul, 2020), and 20.6% among participants of 16-42 years old.(Gyawali et al., 2014) As far as topping off solution, Gyawali

et.al. reported that 15% of participants were topping off solution while Bakkar et. al reported that 32% of participants were topping off solution.(Bakkar & Alzghoul, 2020; Gyawali et al., 2014)

Care of Contact Lens Accessories

Contact lenses accessories are contact lens storage case and disinfection cleaning solutions. These products particularly the contact lens storage case, are significant potential source of infection as they can accumulate bacteria and ultimately increase the risk of contact lens contamination. The risk of contamination increases with improper contact lens storage case replacement and using expired disinfection cleaning solutions.(Y. T. Wu et al., 2010) Lens case contamination rate varies in literature and reported to be between 18%- 85%, and this variation is related to the country where the study was conducted, sample size, study design, microbial sampling and methods. Contact lens wearers pay the least attention to lens case hygiene, and it is the most heavily contaminated item of contact lens accessories with various types of microorganisms. This contamination can lead to microbial keratitis eventually, if the users were not serious in improving their compliance toward lens case hygiene. (Dart et al., 2008b; R A Rosenthal 1, 1995; Stapleton et al., 2008; Y. T. Y. Wu et al., 2015; M. S. Yung et al., 2007)

According to guidelines, contact lens storage cases should be discarded and replaced every 3 months.(AOA, 2019a) a study in Saudi Arabia reported that only 29% of students replace contact lens case every 3 months, while 57% of students replace it after more than three months, 12 % replace it annually and 2% never replace it.(Maqsood & Algalban, 2018) Another study in Maldives reported that 79.4% of participants were replaced their contact lens storage cases within six months and 3.7% had never replaced their storage cases for more than a year.(Gyawali et al., 2014) Wu Y. et al. reported that the frequency of storage case replacement among Australian were 26% replace it monthly, 52% within 2 to 6 months, 10% between 7 to 12 months and 12% replace

storage case more than a year. In addition, they attributed that improved case replacement behavior, to the fact that lens storage case is a complimentary product when purchasing a new cleaning solution. (Y. Wu, Carnt, & Stapleton, 2010)

Another important issue for reducing case contamination is daily case cleaning. The literature demonstrate that the most effective cleaning and disinfection procedure every contact lens wearer must follow after inserting the lens to eye is: rubbing and rinsing the case with fresh clean solution, then wipe the case with clean tissue that allow for removal of bacteria and biofilm, then keep it open and turn it upside to air dry.(CDC, 2020a; Kelsy Steele, 2018) Several studies investigate the case cleaning compliance, and reported that most of contact lens wearers clean storage cases weekly or even monthly, some of them not cleaning cases thoroughly as recommended.(CDC, 2020a; Gyawali et al., 2014; Noushad et al., 2012) Wu Y. et al. report that lens case hygiene is not standardized, and conveys contradicting messages from manufacturers and practitioner, which explains non-compliance regarding case cleaning. (Y. Wu, Carnt, & Stapleton, 2010)

One of the most important recommendations any practitioner must provide to contact lens wearers at time of contact lens dispensing is care of cleaning solution. Each solution valid for 90 days after first use, thus the user must always check the expiration date. In addition to recapping the bottle cover, after every use to prevent contamination. Noushed et al. report that 22% of study participants were not checking expiry date, and they attributed that to practitioner responsibility.(Noushad et al., 2012)

Water and Saliva Exposure

Water exposure to contact lenses includes showering and swimming while wearing contact lens or using water or saliva to clean lenses or lens storage cases. Both Food and Drug Administration and

CDC recommended the avoidance of wearing contact lens while swimming or showering that have a serious consequences particularly microbial keratitis. (CDC, 2007; FDA, 2019)

Wu Y. et al. reported that over a half of Australian contact lens wearers were not wearing goggles or daily disposable contact lenses while swimming. Similarly, a Jordanian study found that 45% of university students were showering and swimming with lenses and 2.8% use water and saliva to clean lenses.(Bakkar & Alzghoul, 2020; Y. Wu, Carnt, & Stapleton, 2010)

Another study reported that 27% used saliva to wet their lenses, and 43% utilized tap water in lens care. This is likely attributed to patients' lack of awareness and knowledge of risky behaviors associated with lens wear and potential lens contamination and increase in the risk of infectious keratitis.(Donshik et al., 2007)

After Care Visits

The recommended follow up appointment (after care visit) is the follow-up time period specified by clinicians after contact lens dispensing and fitting visit, at which the optometrist checks the vision, comfort and fit of contact lens, assesses the ocular health to ensure no adverse contact lens ocular complications are present, and re-enforce proper care and wear behaviors. For new contact lens wearers, follow up appointments are scheduled two weeks of contact lens dispensing visit, while for established contact lens wearers it is scheduled within 6- 24 months, depending on the type of contact lens used.(Efron & Morgan, 2017)

After care visits one of the fundamentals in health care, and it is considered an important cornerstone in contact lens practice. Efron and Morgan reported four key reasons for having after care visits for contact lens wearers: checking for ocular health, maintaining good vision, fulfilling patient satisfaction with contact lens performance,

and enhancing ocular comfort. (Efron & Morgan, 2017)

Bakkar M. et al. reported that the least compliance behavior among Jordanian university students was adherence to after care visits, with a non-compliance rate of 66.4%. Gyawali R. et al. reported that 39.3% of participants were non-compliant with after care visits. Both studies stated the reasons of noncompliance were mainly personal negligence such as patients not remembering after care appointments, or not having any ocular complications requiring additional care, and poor recommendation provided on the importance of aftercare follow up evaluations.(Bakkar & Alzghoul, 2020; Gyawali et al., 2014)

A report published in 2021 post- major pandemic wave, suggested using a video call appointments or telephone calls (scheduled or unscheduled) with contact lens wearers to reduce the possibility of cancelling the appointments during pandemic. This enabled practitioners to triage patients and to book face to face appointments according to the urgency of cases. The authors suggested to keep using this method after pandemic with routine contact lens appointments, either for after care visits, or for taking the history and symptoms prior to contact lens fitting, and for established contact lens wearers to re-educate them on the application and removal of contact lenses and to provide recommendations related to the care and wear of contact lenses. (Naroo et al., 2021) This method may indeed improve adherence to after care visits.

2. 6 Strategies to Improve Compliance and Behavior of Contact Lens Wearers

Non-compliance is considered the primary cause of contact lens discomfort and ocular complications. Several studies investigated strategies to improve the compliance of contact lens wearers. Yung A. et al. conducted an experimental case-control study on Hong Kong university students for 12 months to assess the effectiveness of an enhancement strategy to improve contact lens wearers' compliance. Both groups completed self-review questionnaire at first and final visit. The case group received an extra self-review exercises every three months by email or by hand. In

addition, a six-months after care appointments were scheduled to review exercises and receive consultations and additional microbial assessment of lenses and accessories was conducted. The control group receive consultation at after care visit at six-month appointment. Results indicated that the rate of non-compliance for subject's pre-intervention was 93%, which decreased for both groups in particular aspects of lens care procedure. This improvement is likely related to the extensive education participants received about the lens care procedures at the beginning of the study, and their later reviewing in after care visits. The enhancement strategy utilized in this study did not have a significant effect on the level of compliance between both groups. The researchers attributed this to small sample size, bad habits exist with established contact lens wearers and short study period.(A. M. S. Yung et al., 2007)

McMonnies C W, in two separate articles proposed two strategies to improve contact lens wearers compliance. The first one included providing verbal and written instructions and reinforcing them by photos, in addition to repetition and monitoring compliance frequently through after care visits The second article reported that non-intentional non-compliance is caused by forgetting, and not learning or misunderstanding instructions, particularly those with low level of education or those whom English is the second language. Therefore, McMonnies prepared simple written instructions that were placed online, and designed for all people whether they are of low or high level of education to simplify understanding and learning of lens care compliance behaviors. Furthermore, he suggested that delivering instructions, as a softcopy through email is more effective particularly if instructions are supported by evidence-based research.(McMonnies, 2011b, 2011a)

Another study conducted to assess the effect of education as an enhancement strategy to improve contact lens wearer compliance. The study was a randomized controlled study of two groups, the control group was given verbal instructions and regular after-care consultation every six months.

The intervention group provided with verbal instructions in combination with self-review exercise every 3-months on handling contact lenses and lens care procedure. After 12-month duration, the enhancement strategy was assessed and results showed that there was a statistical significant change only in one lens care behavior, that is related to study population who were generally compliant prior to using enhancement strategy.(Claydon et al., 1997)

2.7 Effectiveness of Mobile Applications on Health Care

Han M., and Lee E. conducted a systematic review of a randomized control trial studies on the effectiveness of mobile application used to improve health behavior changes. Seventeen out of twenty studies show that mobile health apps had positive changes and improvements in health behavior among participants who are strongly familiar with smartphones in their daily lives. However, the other studies show that there was no evidence of change or difference between two groups of case and control. Moreover, they added that each one of the three studies were conducted on one discipline, which is not enough to assess the effectiveness of mobile health apps.(Han & Lee, 2018)

Glynn LG. et al. conducted a randomized control study to evaluate the effectiveness of utilizing mobile app to improve physical activates of patients attending primary care clinics. The participants were divided into intervention group who were trained on the use of mobile app, while the control group were also provided with the app without any training on how to use it. The primary measure was the difference in daily steps from the baseline to week eight. In addition to seven secondary outcomes that had measured before and at the end of the study such systolic and diastolic blood pressure, body mass index, mental health, resting heart rate, and quality of life using two methods. There was a significant difference in the mean between baseline steps and week 8 steps of about 22%, while there was no significant change in the secondary measures in

intervention group. This was attributed to small sample size, which is not enough to detect significant change in secondary measures. For control group there was a decrease in daily steps between baseline and week 8 and no change in secondary measures.(Glynn et al., 2014)

Another study conducted in Norway to assess the effect of mobile app (pregnant+ app) on pregnant women with gestational diabetes mellitus (GDM), of less than 33-week pregnancy. The app has four main icons blood glucose level, dietary intake, physical activities, and diabetic information. In addition, a glucometer was utilized to measure 2-hour blood glucose level of the routine postpartum oral glucose tolerance test, where results were sent to mobile app through Bluetooth. The study was randomized control study, where the intervention group used the app and receive usual routine care, and control group receive only usual routine care. Results show that there was no significant change in the blood glucose level for both intervention and control groups, but the number of emergency cesarean section were decreased for both groups. The major cause of no significant change in the blood glucose level is that only two third of the pregnant women have completed measuring 2-houre blood glucose level postpartum.(Borgen et al., 2019)

2.8 Conceptual Framework of The Study

In the current study, the relationship between the independent variables and dependent variable is a causal relationship, which influenced by the moderator variables that affect the strength and direction of the relationship. The conceptual framework of the study illustrated in figure (1) below:

(1) Represented the dependent variables in the study, which are the behaviors of contact lens wearers. Compliance of contact lens wearers with these behaviors improves the level of compliance and decreases the possibility of developing ocular complications and vice versa.

(2) Represented the dependent variable in the study, which is the level of compliance. Our hypothesis is through introducing the enhancement strategy in this study which is the using of m-health app and written instructions, the level of compliance will be improved.

(3) A-Independent variables that affect the relationship such as the age, teenagers tend to be more non-complaint rather than older users. Moreover, males having difficulty with handling techniques thus they are more non-compliant than females. In addition to the educational level may affect the relation when the users with high education more aware of contact lens complications than those with no or low education. People with longer wearing experience somehow create a routine of contact lens care and wear, that might difficult to change or modify.

B- Moderator variable, which are the intervention used in this study. The m-health app and the written and verbal instructions that will be provided to each participant, in order to increase the level of compliance.

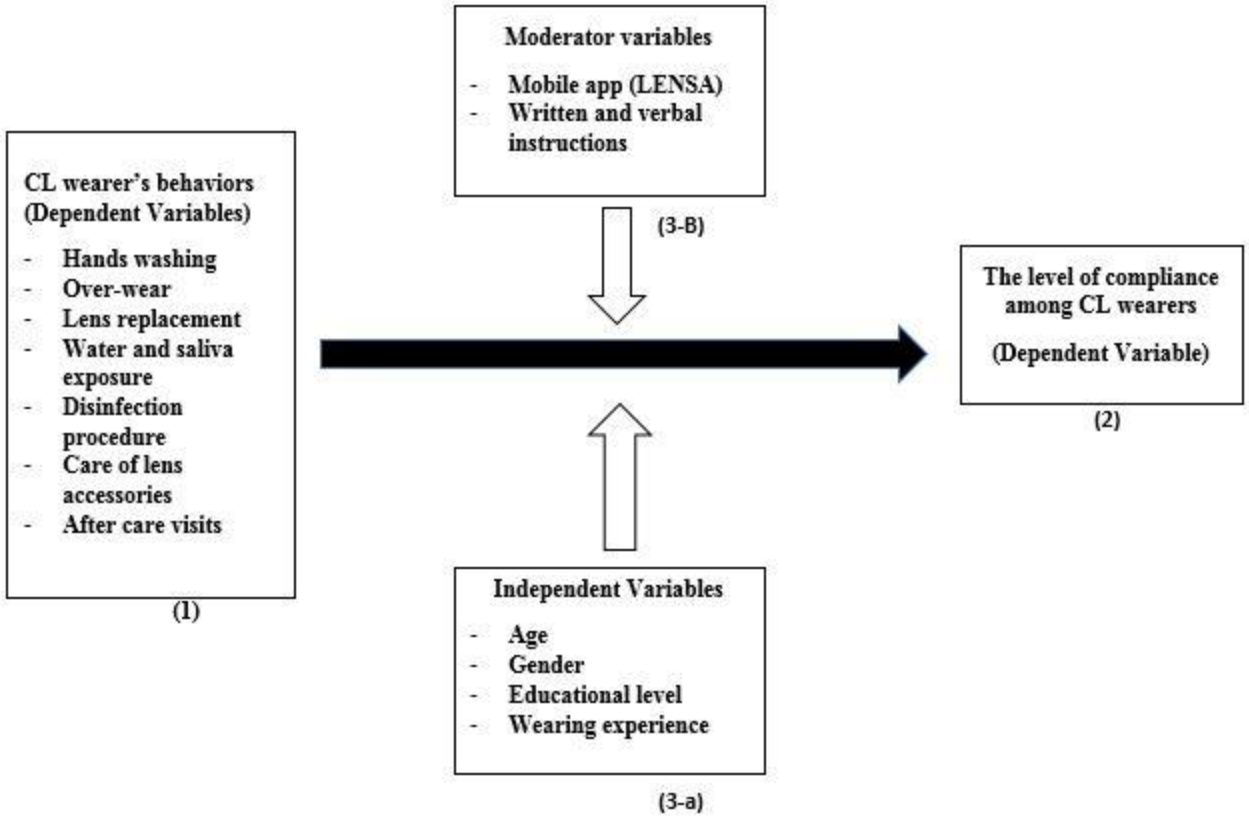

Figure 1: The conceptual framework of the study

2.8 Operational Definitions

Section (1): Demographic Data (3 questions)

1- Gender was codes as 1 for male and 2 for female.

2- Age was coded as 1: (16-25), 2: (26-35), 3: (36-45), 4: (≥46). These categories were followed based on previous literature.(Bakkar & Alzghoul, 2020) (Bakkar, 2020)

3- Educational Level were categorized as follows (1=not-educated, 2= high school,3=diploma degree, 4= bachelor's degree, and 5= higher education).

Section (2): Contact Lens History

This section assessed the contact lens history for established contact lenses wearers through six questions as follows:

1- Total lens wearing history (years) were coded as 1: ≤ 6 month, 2: 6months- 2years, 3: >2 years-4years, and 4: > 4 years.

2- Type of soft contact lenses were categorized as follows 1: Corrective (Prescription), 2: Colored (No prescription), and 3: Corrective with color (Prescription).

3- Modality of Contact lenses wearer were classified to 1: Regular User (wear contact lens for more than five days a week), 2: Occasional User (wear contact lens less than five days a week) these categories were followed based on previous study.(28)

4- Soft contact lens brand was coded as 1: Do not know, Specify included 16 answers that were coded as follow 2: Adria, 3: Dispo, 4: Bella, Acuvue oasys, 5: Biomedics, 6: Morning q, 7: Labella, 8: Freshlook, 9: B&L, 10: Solotica, 11:Biofinity, 12:Proclear, 13: Soflex, 14: Anastasia, 15: Lens me, and 16: Desio

5- Actual Replacement Schedule were coded as 1: Daily, 2: Biweekly, 3:1- month, 4:3- months, 5:6- months, 6: Yearly,7: Other, please specify, and 8: Do not know

6- Your recommended follow up appointment was coded as 1: Do not know, 2: I was not told about follow up appointments, and Specify answers were coded as 3: monthly, 4: 2-months, 5:3-months, 6: 4-months, and 7:6-months.

Section (3): Compliance Status of Lens Wear and Care

This section assessed the compliance status of lens wear and care through using three categories including wearing and replacement habits (6 questions), disinfection procedure (8 questions), and

care of contact lens accessories (6 questions). Each category included positive and negative questions, that were coded as following:

All positive questions were coded as follows 5: always, 4: often, 3: sometimes, 2: rarely, and 1: never.

Negative questions were coded as follows 5: never, 4: rarely, 3: sometimes, 2: often, and 1: always.

Chapter Three: Methodology

3.1 Study Design

A quasi- experiment design that use pre-/ post-intervention and a non-equivalent group was employed.

3.2 Site and Study Setting

The study was conducted in the optometry centers of northern, middle and southern districts in the West Bank between the period of October 2020 and August 2021. The optometry centers participating in the study were Hamad Optometry Center (Jenin), Heba Optometry Center (Nablus), Tarifi Optometry Center (Al-bireh & Ramallah), Tarifi Optometry Center (Bethlehem), and Yousef Optometry Center (Hebron).

3.3 Population and Sampling

The target population included all healthy and asymptomatic soft contact lens wearers who presented to optometry centers for contact lens fitting. The population size was extracted from the Health Information System (HIS) implemented in the selected optometry centers in the period between January 2019 and June 2019. The total population size during this period was 564 soft contact lens wearers, who were distributed among the selected optometry centers as shown in Figure (2).

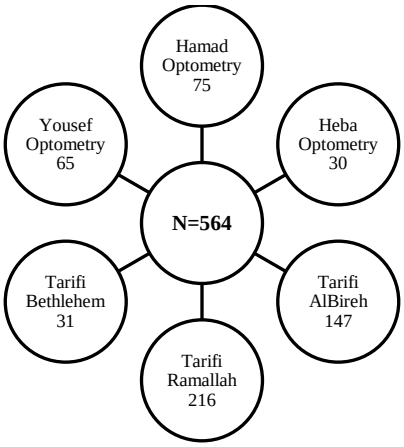

Figure 2: The distribution of the target population in the six optometry centers in northern, middle and southern West Bank.

The raosoft formula was utilized to calculate the sample size with 95% confidence value (z= 1.96), response distribution (r = 0. 5), margin of error (d= 0.050), and population size (N= 564).(Raosoft, 2004) The total sample size was 229 participants. Due to the variation in the number of presenting soft contact lens wearers in each optometry center, proportionate sampling method was utilized to determine the number of sample participants from each center, as shown in Figure (3).(*Proportionate Sampling*, n.d.) One hundred and fifteen (n= 115) participants were in the intervention group, and one hundred and fourteen participants (n= 114) were in the control group. Those assigned to the intervention group were selected from the middle (n= 36), southern (n= 22) and northern (n=45) districts, while those assigned to the control group were all selected from the middle district (n= 97), where the main study team was located.

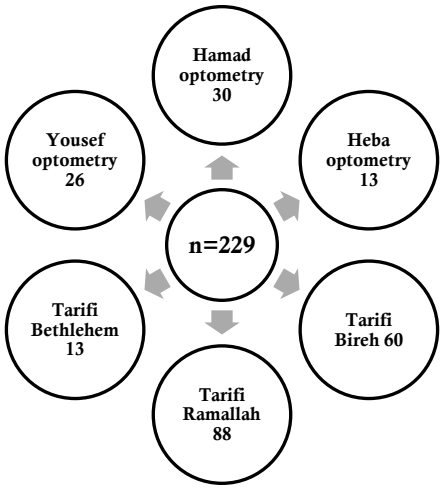

Figure 3: The distribution of the sample population among the six optomerty centers in the nothern, middle and southern districts in West Bank.

3.4 Inclusion and Exclusion Criteria

All established healthy and asymptomatic contact lens wearers, who do not have any signs or symptoms of contact-lens related ocular complications, 16 years of age or older, and those who use either bi-weekly, monthly, quarterly or yearly soft disposable contact lenses, including colored soft lenses, were included in the study. Participants who presented for contact lens fitting and have never worn contact lens previously or participants wearing hard contact lenses or daily disposable contact lens were excluded from the study. Table 1 presents the inclusion and exclusion criteria in this study.

Table 1: The inclusion and exclusion criteria of the study

Inclusion criteria	**Exclusion criteria**
Healthy and asymptomatic	Participants who never worn contact lenses
16 years of age or older	Younger than 16 years old
who use either bi-weekly, monthly, quarterly or yearly soft disposable contact lenses	wearing hard contact lenses or daily disposable

3.5 Study Variables

The level of compliance was the effect which was a dependent variable in this study. While the cause were behaviors toward lens wear and care procedures, replacement and wearing behaviors such as wearing hours, hands hygiene, and the care of contact lens accessories and it were also considered as dependent variables. Moderator variables were the use of mobile applications, verbal and written instructions, and wearing history, and the demographic variables (age, gender, and education) were the independent variables. Moderator and independent variables might influence the level, direction and the presence of the relationship.

3.6 Data Collection Tools

The data collection was conducted using three tools: a face-to-face structured questionnaire (pre-intervention phase), a telephone questionnaire (pre-intervention and post-intervention phase), and an online questionnaire (pre-intervention and post-intervention phase) on both the control and intervention groups.

Questionnaire Content

Information about soft contact lens brand and its MRRF was initially recorded for all participants from clinician's medical records. Demographical data and contact lens wear history were obtained from all participants. To assess the level of compliance, questions were obtained from previously published non-validated questionnaire, and re-modified by our research team based on their clinical expertise (Noushad et al., 2012).

The questionnaire included in Appendix (1) consisted of 30 questions classified into three sections as described below.

First section: demographical data including age, gender and level of education (4 questions).

Second section: consisted of 6 questions relating to contact lens wear history including: total time of lens wearing history, type of soft contact lenses, modality of contact lenses wearers, soft contact lens brand, actual replacement schedule, and the recommended follow up appointment.

Third section: Assessed the compliance status of lens wear and care behaviors, which included 20 questions categorized into three categories that consisted of positive and negative questions. In category A, information about wearing and replacement habits (questions 11-16) was collected, while in category B, information about disinfection procedures (question 17-24) was collected, and in category C, information about care of accessories (questions 25-30) was collected.

The pre-intervention questionnaire consisted of section 1, section 2 and section 3. The post-intervention questionnaire consisted of section 3 only which was utilized to compare the compliance status and assess the effectiveness of the enhancement strategy.

Questionnaire Validity and Reliability

Questionnaire Reliability

The internal consistency test was used to assess the reliability of the questionnaire by calculating the reliability coefficient (Cronbach's alpha) for items under the Likert scale. The reliability coefficient was calculated to be 71.5%, as shown in Table 2, which is considered to be an acceptable level of reliability.(Stephanie Glen, n.d.)

Table 2: The reliability coefficients of the questionnaire administered in this study

Cronbach's Alpha	N of Items
0.715	20

Questionnaire Validity

To test questionnaire validity, double translation was conducted. The questionnaire was designed in English language, and was then translated into Arabic by two experts in the fields. After which, it was back translated into English language to ensure that the questions carry the same meaning in both languages. Additional questionnaire validation process was conducted through pilot testing. The questionnaire was tested on a small sample size of 15 respondents at Tarifi Optometry Centers at Al-Bierh and Ramallah, to ensure the appropriateness and the clarity of the questions to the target population, and a final modified version was prepared.

Operational Framework

The participants were divided into two groups: the intervention group and the control group. Figure 4 below illustrates the operational framework used in this study.

For the intervention group, the questionnaire was conducted at the initial visit before the fitting and dispensing process began either through face to face interview, or through telephone interview, or through online forms. Upon completion of the questionnaire, the participants were educated on the use of mHealth app LENSA, and they were provided with verbal and written instructions on the proper contact lens compliance behaviors. After three months, the post-intervention questionnaires were collected either through telephone interview or through online forms that were sent through WhatsApp.

For the control group, the questionnaire was conducted at the initial visit before the fitting and dispensing process began either through face to face interview or through telephone interview. After which, participants received only structured verbal instructions on proper contact lens care and wear behaviors. After three months, the post-intervention questionnaire was collected either through a telephone interview or through an online form that was sent through WhatsApp.

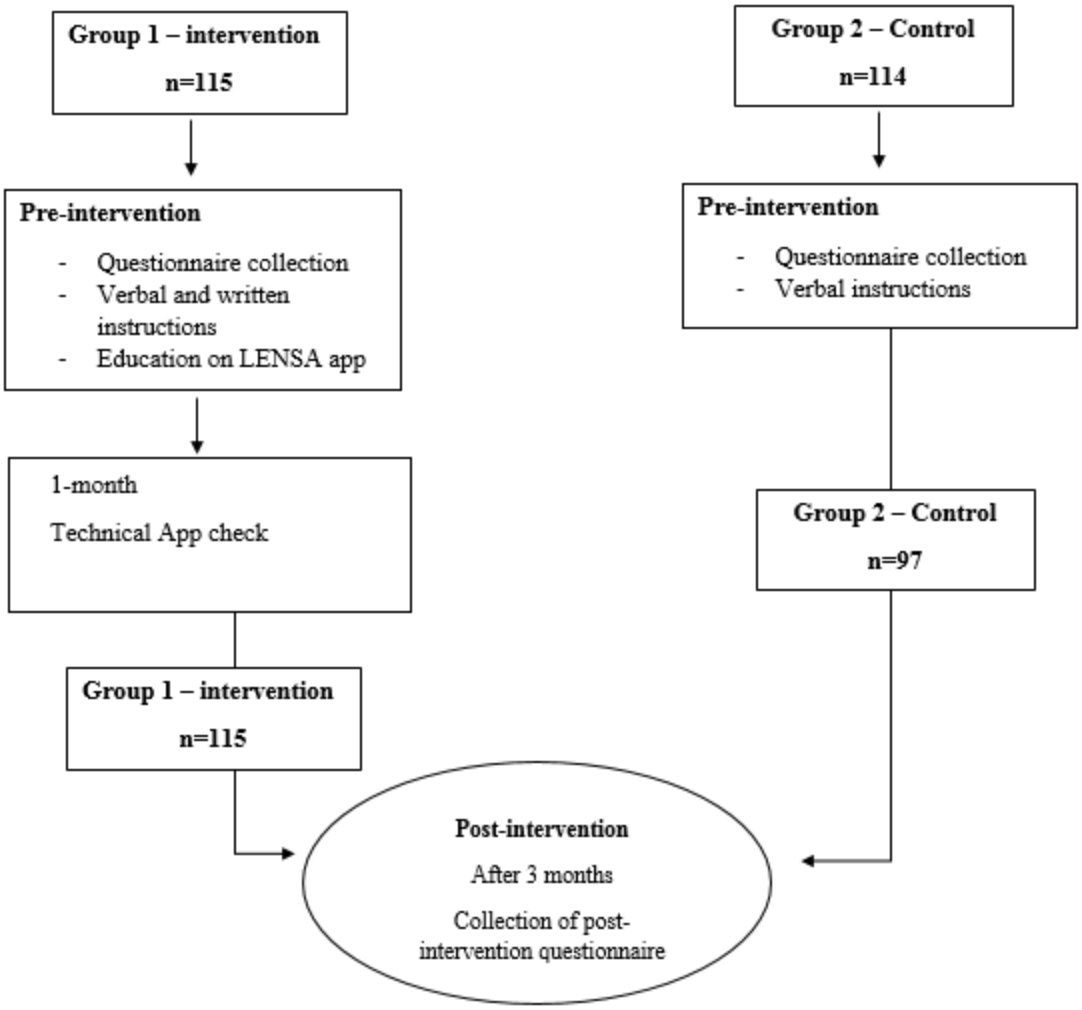

Figure 4:Flow chart of the operational frame work for both intervention and control groups

The Enhancement Strategies

The main enhancement strategy that was provided to the participants in the intervention group was mHealth app (LENSA), which is a multiple function app that to our knowledge has not been scientifically validated. The data collection team either downloaded it to each participant or they shared the app link for whom preferred to conduct the questionnaire online or through phone call. After downloading the app from app store or play store, the user will select the type of contact lens

(soft or rigid) they use. Based on the first selection, the app will display all contact lens brands and its recommended replacement time. By default, when the user selects the contact lens brand, the app displays the initial wearing date of contact lens and the expiration date (time of replacement). The app will send a notification in three cases: at the end of the day after 8 hours to remind the user of contact lens removal, a reminder to wear contact lenses if the user does not enter the initial wear time at any time, and a notification reminding the user of contact lens replacement/expiration date. In addition to the reminder function, the app contains an icon known as care center for contact lens wearers' education, that includes all instructions about contact lens care and wear using photos and written instructions.

The other enhancement strategy, attached in Appendix (4), that was utilized in this study was written instructions in Arabic that included instructions related to lenses wear, cleaning process, and disinfection.

3.7 Data Management

Data Entry- Storage - Cleaning

An excel sheet was created to ease transmitting data to SPSS program for data analysis. The data was coded and entered to the excel sheet. An analysis plan was prepared based on the research questions and study objectives. Data cleaning was performed to ensure that there are no missing data, correct coding was entered, and to delete any duplications.

The response to each question in section 3 of the pre- and post-intervention questionnaire was graded using Likret grading scale from 5 to 1. For the positive questions, those who responded always meant that the behavior was performed daily, often meant that the behavior was performed day after day, sometimes meant that the behavior was done 3-4 times per week, rarely meant the behavior was done once a week, while never meant that the participant never performed this

behavior. Section 3 of the questionnaire also included four negative questions (questions 13 and 14 in category A, question 18 in category B and question 28 in category C). For those questions, scoring of responses were opposite, where a score of 5 was given for those who responded never (excellent compliance), a score of 4 for rarely, a score of 3 for sometimes, a score of 2 for often, and a score of 1 for always (poor compliance). For the negative questions, those who responded (never) meant that they did not perform the negative behavior, (rarely) meant that the negative behavior was performed less than once a week, (sometimes) meant that the negative behavior was performed 3-4 times a week, (often) meant the negative behavior was performed day after day, and finally (always) meant that the participant performed the negative behavior on a daily basis.

The compliance rate is the numerical value or the percentage of participants who answered always or often to the questions relating to lens care and wear behaviors. The level of compliance was classified into three classifications according to the percentage of compliant participants, based on a previously published study.(Philip Morgan, 2008) For rate of compliance equal to or more than 80%, participants would be considered to have high compliance level in a specific behavior, those with the rate of compliance between 40% and 80% were considered to have moderate level of compliance, and those with less than 40% compliance rate were considered to have low level of compliance.

The compliance scores are the scores from 5-1, that measured the frequency of performing lens care and wear behavior using the Likert scale. The average compliance score was calculated for all categories (A, B & C), and for each individual category within section 3. An average score equal to 4 or more was considered as having total compliance to lens wear and care, while an average score of less than 4 was considered as total non-compliance.

3.8 Statistical Analysis

Test of Normality

An assessment of the normality of data was conducted using the Klimogorov-smirnov test. The mean of each item in the Likert scale was used to apply the test of normality. For this test, the null hypothesis (H0) states that the sample data are not significantly different than a normal population (*normal distributed population)*. Results from the normality test showed that *p*-value >0.05, which meant that the null hypothesis would be rejected as shown in Table 3, and that the sample data in this study is significantly different from the normal population (non-normal distribution of population).

Table 3: Test of normality of data

Category	**Kolmogorov-Smirnov[a]**	
	Statistics	**P-value**
Wearing and Replacement Habits	0.053	0.000
Disinfection Procedures	0.114	0.000
Care of contact lenses Accessories	0.151	0.000
Total	**0.98**	**0.000**

Data Analysis

The data analysis was performed using Statistical Package for Social Science (SPSS) version 20. Frequencies and percentages were calculated for all categorical variables. Median and mean were used as the measures of central tendency for Likert-scale variables. A *p*-value lower than 0.05 was considered statistically significant. Kolmogorov-Smirnov test was conducted to test the normality of distribution of the data. Non-parametric statistical tests were used Mann- Whitney U test, Kruskal- Walli's test, and Wilcoxon Signed Rank test. The Mann-Whitney U test was used to compare if there was a statistically significant difference in the dependent variable between two independent groups (intervention and control). The Mann-Whitney U test rank all the values of

the variable descending and calculating the mean of ranks for each group. The difference between the mean rank for the intervention group and the mean rank of the control group was then calculated. The Kruskal-Wallis Test was used to determine if there was a statistically significant difference between several means among the participants. The Wilcoxon Signed Rank test, was conducted to examine the relation between pre- and post-intervention.

3.9 Eliminating Bias

A Quasi-experiment avoids ethical concerns associated with random assignment, through conducting studies on real world settings instead of artificial laboratory settings, and this improves external validity. On the other hand, the internal validity decreases without randomization, therefore confounding variables were controlled using a

large sample size and a comparable control group.(Chant A. Chiang; Rajiv S. Jhangiani; and Paul C. Price, 2015; Lauren Thomas, 2020)

3.10 Ethical Consideration

This research followed the tenets of the Declaration of Helsinki. Ethical approval to conduct this study was obtained from the Helsinki Institutional Review Board (IRB) in Gaza City, in addition to the Faculty of Graduate Studies at the Arab American University of Palestine. Written and verbal informed consent, attached in Appendix (3), was taken from all participants who agreed to participate in the study, and all consent forms entailing study objectives and significance were provided to participants in Arabic language to ensure they fully understand what their participation requires.

Chapter Four: Results

A total of 229 contact lens wearers were interviewed in this study at six optometry centers in northern, middle and southern districts in the oPt. Twenty-eight (n=28) participants did not complete the post-intervention questionnaire and were excluded from the study. Of the excluded participants, one was under 14 years old, two were using daily disposable soft contact lens, and three underwent refractive surgery during the study timeline. Ten participants stopped using contact lenses due to ocular complications, and working from home during COVID-19 pandemic. Additionally, twelve participants were lost to follow up since the study team was unable to contact them by phone.

4.1 Demographical Data

Of all participants (n=201) who completed the pre- and post- intervention questionnaires, a total of 104 participants were in intervention group, while a total of 97 participants were in the control group. There were 184 (91.5%) females, 92 in the intervention group and 92 in the control group. Of the 17 (8.5 %) males participating in the study, 12 of them were in the intervention group and five were in the control group. The majority of participants were between 16 – 25 years of age (49.8%) with a mean age of 27.39 years, and held bachelor degrees (48.3%). Table 4 shows the demographical characteristics of the study population.

Table 4: Demographical characteristics of the study population (n=201)

Demographical Variables		**Frequency (N=)**	**Percentage (%)**
Gender	Male	17	8.50%
	Female	184	91.5%
Age Group	16 - 25	100	49.8%
	26 - 35	71	35.3%
	36 - 45	26	12.9%
	≤46	4	2.00%
Educational Level	None	5	2.50%
	High School	54	26.9%
	Diploma	20	10.0%
	Bachelor	97	48.3%
	Higher education	25	27.4%

4.2 Contact Lens Wear History

Total Lens Wearing History

Of the 104 contact lens wearers in the intervention group, 52.9% have worn contact lenses for more than four years. While among the 97 contact lens wearers in the control group, 44.4% have worn their contact lenses for more than four years. Table 5 shows the distribution of the total lens wearing history among participants in both the intervention and control groups.

Table 5: Distribution of participants by total lens wearing history

Total lens wearing history	**Intervention N (%)**	**Control N (%)**
≤6 months	6.70%	11.3%
> 6 month - 2 years	18.3%	23.7%
> 2 years - 4 years	22.1%	20.6%
> 4 years	52.9%	44.4%

Type of Soft Contact Lenses

In the intervention group, 64.5% of participants were using corrective contact lenses, 15.4% were using colored contact lenses and 19.7% were using corrective with color contact lenses. While in the control group, 66% of participants were wearing corrective contact lenses, 18.6% were using colored contact lenses, and 15.4% were using corrective with color contact lenses. Table 6 shows the distribution of participants according the type of soft contact lens worn.

Table 6: Distribution of participants by type of soft contact lenses worn

Type of contact lenses	**Intervention (N)%**	**Control N (%)**
Corrective (Prescription)	65.4%	67.0%
Colored (No prescription)	15.4%	18.6%
Corrective with color (Prescription)	19.2%	14.4%

Soft Contact Lens Brands

As shown in Figure 5, half of the participants (50.2%) did not know the brand of contact lenses that they are wearing. 10.9% of participants were wearing Adria (Interojo), a soft contact lens that is available in color with prescription, while 8% were wearing Dispo soft contact lenses (Soflex). The rest of participants were wearing a variety of other soft contact lens brands.

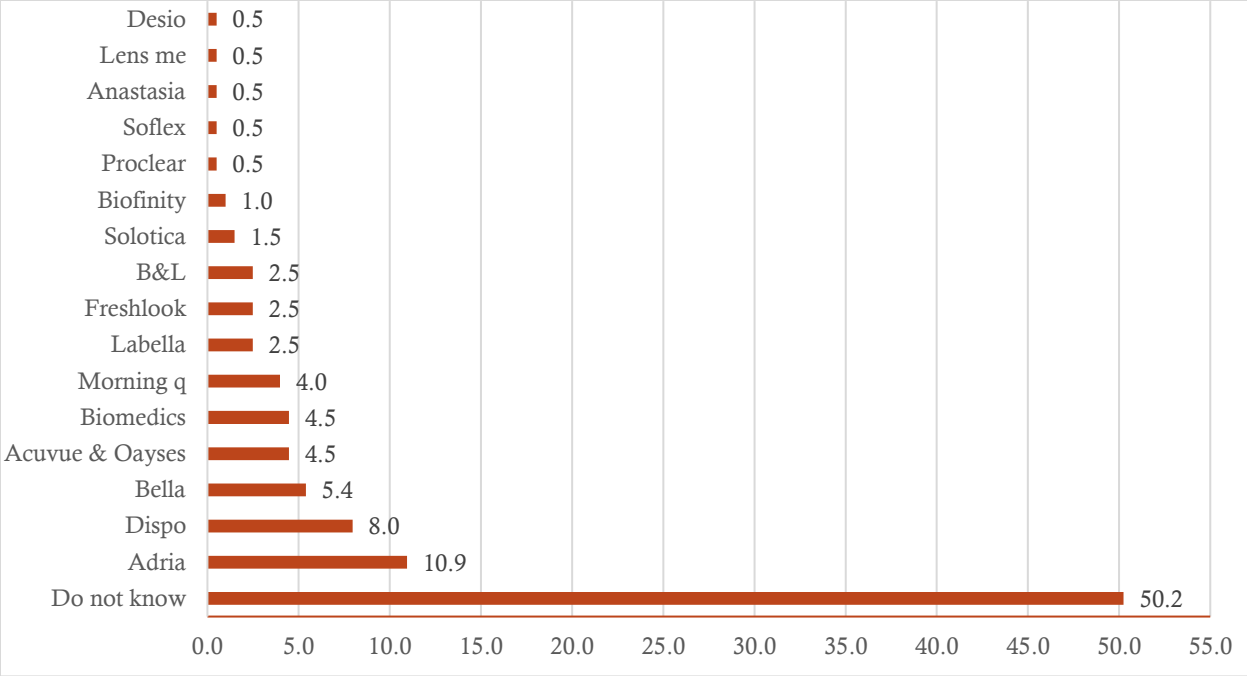

Figure 5: Distribution of the soft contact lenses brands used by the participants in this study

Actual Replacement Schedule

In the intervention group, the participants' answers varied about actual replacement schedules. 26% of participants replaced contact lenses monthly, 19.2% replaced contact lenses every 3 months, 25% replaced contact lenses every 6 months and 3.8% did not know the actual replacement frequency of contact lenses. In the control group, 30.4% of participants replaced contact lens monthly, 16% replaced them every 6 months, 4.6% did not know the replacement schedule, and 12.9% use other replacement schedules that were not specified in the questionnaire. The distribution of participants by actual replacement frequency among the intervention and control group is shown in Table 7.

Table 7: Percentage distribution of participants by actual replacement schedule

Replacement Schedule	Intervention		Control	
	Frequency (N=)	Percentage (%)	Frequency (N=)	Percentage (%)
Daily	0	0.00%	0	0.00%
Bi-weekly	2	1.90%	2	2.10%
1 Month	27	26.0%	29	29.9%
3 Months	20	19.2%	28	28.9%
6 Months	26	25.0%	14	14.4%
Yearly	7	6.70%	8	8.20%
Others	18	17.3%	10	10.3%
Do Not Know	4	3.80%	6	6.20%
Total	**104**	**100%**	**97**	**100%**

The Recommended Follow Up Appointment

Approximately, half of the participants (56.7%) in the intervention group, and two third of the participants (71.1%) in the control group reported that they were never told about follow up appointments. Of those who did not know when their follow up appointment was scheduled, 14% were in the intervention group and 6.2% were in the control group. Table 8 shows the distribution of participants by their scheduled aftercare visits.

Table 8: Distribution of participants by the recommended follow up appointment (Aftercare visit)

Variable	Intervention		Control	
	Count	%	Count	%
Do not know	15	14.4%	6	6.20%
I was not told about follow up appointments	59	56.7%	69	71.1%
Monthly	2	1.90%	0	0.00%
2 months	3	2.90%	1	1.00%
3 months	3	2.90%	6	6.20%
4 months	1	1.00%	0	0.00%
6 months	16	15.4%	9	9.30%
Yearly	5	4.80%	6	6.20%
Total	**104**	**100%**	**97**	**100%**

4.3 Compliance Status of Lens Wear and Care

4.3.1 Category A: Wearing and Replacement Habits

For the intervention group, the mean compliance score for wearing and replacement habits was (3.78) pre- intervention and (3.94) post-intervention. This increase was significant (Wilcoxon signed ranks test, $p<0.05$) for all behaviors assessed in this category ($p=0.013$). Furthermore, three out of six behaviors in this category had a statistically significant difference pre- and post-intervention. These behaviors included adherence to replacement schedule, napping in contact lenses, and adherence to after-care visits. Table 9 presents the mean compliance score for wearing and replacement habits category.

Table 9: Descriptive analysis for compliant behaviors related to wearing and replacement habits for the intervention group.

Behavior	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I wear my lenses as per the recommended wearing time each day (not more than 8 - 12 hours)	Never	1.90	4.1	4.0	1.90	4.3	5.0	0.240
	Rarely	5.80			6.70			
	Sometimes	18.3			10.6			
	Often	26.9			25.0			
	Always	47.1			55.8			
I discard my used contact lenses and switch to a new pair as recommended	Never	10.6	3.9	5.0	3.80	4.31	5.0	**0.009***
	Rarely	22.1			4.80			
	Sometimes	11.5			5.80			
	Often	7.70			27.9			
	Always	48.1			57.7			
I do nap (sleeping for short periods) in my contact lenses	Never	70.2	4.4	5.0	71.2	4.6	5.0	**0.047***
	Rarely	11.5			19.2			
	Sometimes	11.5			7.70			
	Often	3.80			1.90			
	Always	2.90			0.00			
I sleep overnight in my contact lenses	Never	92.3	4.9	5.0	97.1	4.9	5.0	0.054
	Rarely	3.80			1.00			
	Sometimes	1.90			1.00			
	Often	1.90			1.00			
	Always	0.00			0.00			
If my eyes look red or irritated, I remove my lenses as soon as possible	Never	3.80	4.6	5.0	1.00	4.7	5.0	0.420
	Rarely	0.00			2.90			
	Sometimes	2.90			2.90			
	Often	14.4			9.60			
	Always	78.8			83.7			
I attend all the recommended after-care visits suggested by my practitioner	Never	36.5	2.7	2.0	19.2	3.5	4.0	**0.000***
	Rarely	15.4			8.70			
	Sometimes	11.5			17.3			
	Often	11.5			17.3			
	Always	25.0			37.5			
All Habits			**3.78**	**5.0**		**3.94**	**5.0**	**0.013***

As for the control group, Table 10 shows the mean compliance score was (3.74) pre-intervention and (3.99) postintervention, with an overall statistical significance of (*p*- value= 0.00). Two behavioral habits, including daily wearing time of contact lenses and adherence to recommended

after-care visits, had a statistically significant difference between pre- and post-intervention

Behavior	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I wear my lenses as per the recommended wearing time each day (not more than 8 -12 hours)	Never	5.20	4.3	5.0	1.00	4.5	5.0	**0.040***
	Rarely	4.10			3.10			
	Sometimes	8.20			7.20			
	Often	24.7			18.6			
	Always	57.7			70.1			
I discard my used contact lenses and switch to a new pair as recommended	Never	4.10	4.20	5.0	3.10	4.7	5.0	0.088
	Rarely	4.10			3.10			
	Sometimes	14.4			12.4			
	Often	22.7			16.5			
	Always	54.6			64.9			
I do nap (sleeping for short periods) in my contact lenses	Never	83.5	4.87	5.0	78.4	4.7	5.0	0.616
	Rarely	9.30			14.4			
	Sometimes	6.20			7.20			
	Often	1.00			0.00			
	Always	0.00			0.00			
I sleep overnight in my contact lenses	Never	96.9	5.0	5.0	96.9	4.9	5.0	0.705
	Rarely	3.10			2.10			
	Sometimes	0.00			0.00			
	Often	0.00			0.00			
	Always	0.00			1.00			
If my eyes look red or irritated, I remove my lenses as soon as possible	Never	2.10	4.8	5.0	1.00	4.8	5.0	0.488
	Rarely	1.00			1.00			
	Sometimes	3.10			0.00			
	Often	7.20			11.3			
	Always	86.6			86.6			
I attend all the recommended after-care visits suggested by my practitioner	Never	62.9	1.9	1.0	20.6	3.3	3.0	**0.00***
	Rarely	11.3			12.4			
	Sometimes	10.3			18.6			
	Often	4.10			10.3			
	Always	11.3			38.1			
All Habits			**3.74**	**5**		**3.99**	**5.00**	**0.00***

(Wilcoxon signed ranks test, $p<0.05$).

Table 10: Descriptive analysis for compliant behaviors related to wearing and replacement habits for the control group

In Table 9 and 10 there were a difference in means in the wearing and replacement habits, between pre-intervention and post-intervention for each behavior for the intervention and control group and this difference was significant depending on *p*-value. In order to examine the significance of difference between the intervention and the control group in this whole category, the confidence interval were measured for the differences of both the intervention and control, thus based on the Table 11 below: for the intervention group the difference of means between pre-and post-intervention, with a 95% confidence level, the confidence interval is between (-26.2, -0.6). For the control group, the confidence interval is between (-36.3, -14.4). Hence, there is no difference between in the intervention group and the control because there is an intersect in the two confidence intervals as shown in Figure 6.

Table 11: The independent t-test for wearing and replacement habits category.

Participant type		t-test for Equality of Means						
		T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
Intervention	Equal variances assumed	-2.072	206	.040	-.13462	.06498	-.26272	-.00651
	Equal variances not assumed	-2.072	204.703	.040	-.13462	.06498	-.26272	-.00651
Control	Equal variances assumed	-4.584	192	.000	-.25430	.05547	-.36371	-.14488
	Equal variances not assumed	-4.584	190.214	.000	-.25430	.05547	-.36372	-.14487

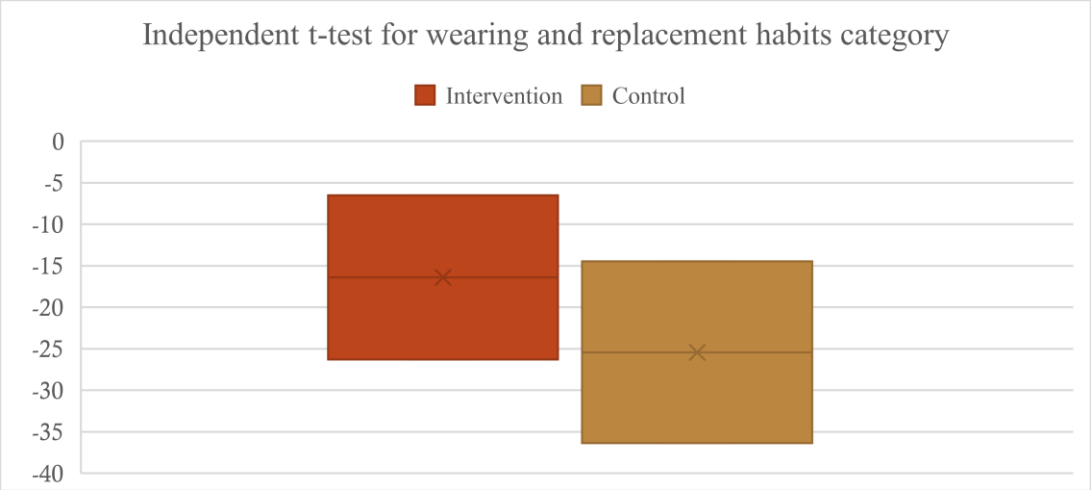

Figure 6: The intersection in the confidence intervals of the difference of means between the intervention and the control group in wearing and replacement habits category.

The compliance rate for participants in the intervention and control group pre- and post-intervention is shown in Table 12. Generally, the rate of compliance pre- and post-intervention for both groups increased for most behaviors in the wearing and replacement category. For the intervention group, there was an improvement in the compliance rate for all behaviors, a statistically significant improvement (*p-value* = 0.035) was in adherence to recommended after care visits and the compliance rate improved from 36.5% to 54.8%. In the control group, there was an improvement in most of the behaviors, particularly in adherence to aftercare visits, where there was an improvement in compliance rate from 15.5% to 48.5% with a statistically significant (*p-value* =0.000).

Table 12: The compliance rate for wearing and replacement habits pre- and post-intervention

Behavior	Intervention			Control		
	Pre-intervention Compliance Rate/ Level	Post-intervention Compliance Rate/Level	p-Value	Pre-intervention Compliance Rate/Level	Post-intervention Compliance Rate/Level	p-Value
I wear my lenses as per the recommended wearing time each day (not more than 8 - 12 hours)	74.0 Moderate	80.8 High	0.705	82.5 High	88.7 High	0.693
I discard my used contact lenses and switch to a new pair as recommended	70.2 Moderate	85.6 High	0.052	77.3 Moderate	81.4 High	0.149
I do nap (sleeping for short periods) in my contact lenses	81.7 High	90.4 High	0.558	92.8 High	92.8 High	0.138
I sleep overnight in my contact lenses	96.2 High	98.1 High	0.180	100.0 High	99.0 High	0.317
If my eyes look red or irritated, I remove my lenses as soon as possible	93.3 High	93.3 High	0.157	93.8 High	97.9 High	0.655
I attend all the recommended after-care visits suggested by my practitioner	36.5 Low	54.8 Moderate	**0.035***	15.5 Low	48.5 Moderate	**0.000***

4.3.2 Category B: Disinfection Procedure

For the intervention group, as seen in Table 13, the results showed that the overall mean compliance score related to adherence to disinfection procedures was relatively high (4.31), and it increased post-intervention (4.60). This increase was significant (Wilcoxon signed ranks test, $p<0.05$) in six out of eight behaviors including hand washing($p=0.026$), contact lens rubbing ($p=0.000$), contact lens rinsing ($p=0.01$), checking contact lenses for debris and damage ($p=0.003$), soaking contact lenses with fresh solution ($p=0.000$), and soaking contact lenses for more than 4 hours every night ($p=0.011$).

Table 13: Descriptive analysis for compliant behaviors related to disinfection procedures for intervention group.

Procedure	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I wash my hands before handling my contact lenses	Never	2.90	4.5	5.0	1.90	4.7	5.0	**0.026***
	Rarely	1.90			0.00			
	Sometimes	10.6			5.80			
	Often	6.70			10.6			
	Always	77.9			81.7			
I use tap water or saliva to disinfect my lenses if no disinfection solution is available	Never	88.5	4.8	5.0	96.2	4.9	5.0	0.244
	Rarely	5.80			0.00			
	Sometimes	2.90			1.00			
	Often	0.00			1.00			
	Always	1.90			1.90			
I rub my lenses with solution on both sides each time I disinfect them	Never	24.0	3.4	4.0	3.80	4.2	5.0	**0.000***
	Rarely	7.70			2.90			
	Sometimes	16.3			15.4			
	Often	12.5			22.1			
	Always	39.4			55.8			
I rinse my contact lenses with solution after the rubbing step	Never	21.2	3.6	4.5	4.80	4.3	5.0	**0.01***
	Rarely	5.80			4.80			
	Sometimes	10.6			14.4			
	Often	12.5			12.5			
	Always	50.0			63.5			
I check my lenses for debris & damage before insertion	Never	1.90	4.4	5.0	0.00	4.8	5.0	**0.003***
	Rarely	3.80			1.00			
	Sometimes	9.60			2.90			
	Often	17.3			15.4			
	Always	67.3			80.8			
I use fresh disinfecting solution to store / soak my lenses after each use	Never	1.90	4.1	5.0	0.00	4.5	5.0	**0.000***
	Rarely	6.70			1.90			
	Sometimes	21.2			13.5			
	Often	21.2			20.2			
	Always	49.0			64.4			
When I soak my contact lenses, I fill the lens case with enough fresh disinfecting solution to cover the lenses completely	Never	0.00	4.7	5.0	0.00	4.9	5.0	0.084
	Rarely	0.00			0.00			
	Sometimes	6.70			3.80			
	Often	12.5			6.70			
	Always	80.8			89.4			
I soak my contact lenses in the disinfecting solution for more than 4 Hrs every night	Never	0.00	4.9	5.0	1.90	4.7	5.0	**0.011***
	Rarely	0.00			2.90			
	Sometimes	3.80			4.80			
	Often	3.80			7.70			
	Always	92.3			82.7			
ALL			**4.31**	**5.0**		**4.60**	**5.0**	**0.00**

The compliance scores for the control group is displayed in Table 14, with results indicating that the mean compliance score was (4.42) pre-intervention and (4.64) post-intervention. Overall, this increase was significant (Wilcoxon signed ranks test, $p = 0.00$). Only three out of eight disinfection behaviors had a significant difference pre- and post-intervention including contact lenses rubbing (*p*- value= 0.00), contact lens rinsing (*p*-value= 0.007), and checking contact lenses for debris & damage (*p*- value=0.005).

Table 14: Descriptive analysis for compliant behaviors related to disinfection procedures for control group.

Procedure	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I wash my hands before handling my contact lenses	Never	0.00	4.8	5.0	0.00	4.8	5.0	0.629
	Rarely	1.00			0.00			
	Sometimes	6.20			1.00			
	Often	2.10			13.4			
	Always	90.7			85.6			
I use tap water or saliva to disinfect my lenses if no disinfection solution is available	Never	93.8	4.9	5.0	96.9	4.9	5.0	0.465
	Rarely	3.10			1.00			
	Sometimes	3.10			2.10			
	Often	0.00			0.00			
	Always	0.00			0.00			
I rub my lenses with solution on both sides each time I disinfect them	Never	32.0	3.3	4.0	5.20	4.2	5.0	**0.00***
	Rarely	4.10			3.10			
	Sometimes	12.4			11.3			
	Often	7.20			26.8			
	Always	44.3			53.6			
I rinse my contact lenses with solution after the rubbing step	Never	23.7	3.7	5.0	5.20	4.3	5.0	**0.007***
	Rarely	2.10			4.10			
	Sometimes	9.30			8.20			
	Often	6.20			24.7			
	Always	58.8			57.7			
I check my lenses for debris & damage before insertion	Never	5.20	4.5	5.0	0.00	4.8	5.0	**0.005***
	Rarely	4.10			1.00			
	Sometimes	5.20			2.10			
	Often	6.20			13.4			
	Always	79.4			83.5			
I use fresh disinfecting solution to store / soak my lenses after each use	Never	1.00	4.4	5.0	1.00	4.5	5.0	0.195
	Rarely	2.10			3.10			
	Sometimes	15.5			5.20			
	Often	18.6			22.7			
	Always	62.9			68.0			
When I soak my contact lenses, I fill the lens case with enough fresh disinfecting solution to cover the lenses completely	Never	1.00	4.8	5.0	1.00	4.8	5.0	0.906
	Rarely	0.00			0.00			
	Sometimes	6.20			4.10			
	Often	6.20			9.30			
	Always	86.6			85.6			
I soak my contact lenses in the disinfecting solution for more than 4 Hrs every night	Never	1.00	4.9	5.0	0.00	4.8	5.0	0.068
	Rarely	0.00			3.10			
	Sometimes	1.00			4.10			
	Often	3.10			5.20			
	Always	94.8			87.6			
ALL			**4.42**	**5.0**		**4.64**	**5.0**	**0.00***

As presented before in Table 13 and 14, there was a difference of means between pre-intervention and post-intervention in each behavior in disinfection procedure category, for the intervention and control group and this difference was significant depending on *p*-value.

Confidence interval were measured to check the significance of the difference of means in this category between the intervention group and the control group, as shown in Table 15 in the intervention group the difference of means between pre-intervention and post-intervention, with 95% confidence level, and the confidence interval is between (-40.3, -16.8). For the control group, the confidence interval is between (-35.2, -9.8). Hence, there is no difference between in the intervention group and the control because there is an intersect in the two confidence intervals as shown in Figure 7.

Table 15: The independent t-test for the disinfection procedure category.

Participant type		**t-test for Equality of Means**						
		t	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
							Lower	**Upper**
Intervention	**Equal variances assumed**	-4.783-	206	.000	-.28606-	.05981	-.40397-	-.16815-
	Equal variances not assumed	-4.783-	194.076	.000	-.28606-	.05981	-.40401-	-.16810-
control	**Equal variances assumed**	-3.492-	192	.001	-.22552-	.06458	-.35290-	-.09813-
	Equal variances not assumed	-3.492-	183.292	.001	-.22552-	.06458	-.35294-	-.09809-

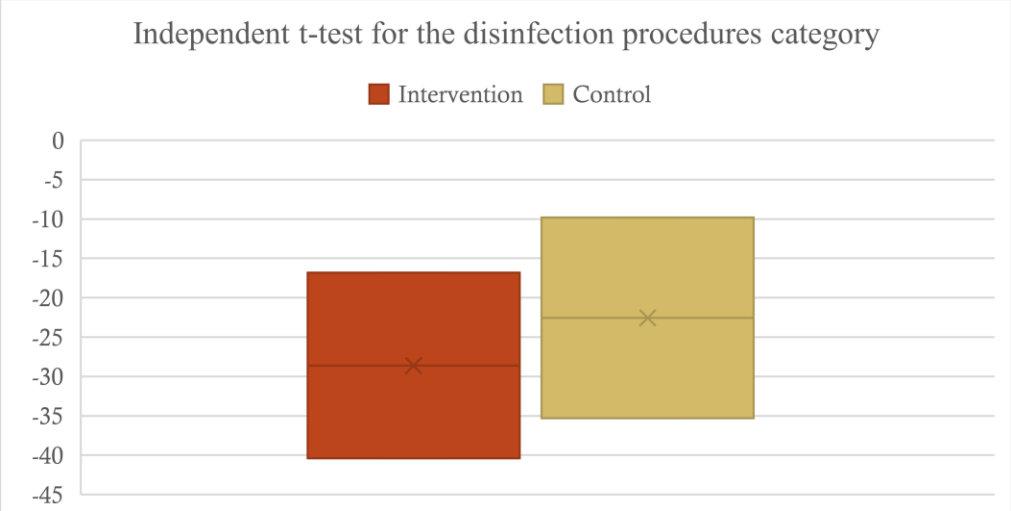

Figure 7: The intersection in the confidence intervals of the difference of means between the intervention and the control group in the disinfection procedures category.

The compliance rate for participants in the intervention and control groups pre- and post-intervention for disinfection procedures is shown in Table 16. For the intervention group, 84.6% of participants were compliant with hand washing pre-intervention, and the rate improved to 92.3% post-intervention. There was a noticeable improvement in the compliance rate in the contact lenses disinfection steps, where the rates improved for rubbing (51.9%), rinsing (62.5%) and soaking (70.9%) to 77.9%, 76.0% and 84.6%, respectively. Additionally, there was a significant difference pre- and post-intervention in soaking contact lenses for more than 4 hours every night where the compliance decreased from 96.2% to 90.4% (*p-value*= 0.010). For the control group, there was an overall improvement in all disinfection behaviors, particularly for contact lenses rubbing, where there was a significant (*p-value* =0.049) improvement in compliance rate from 51.5% pre-intervention to 80.4% post-intervention.

Table 16: The compliance rate for the disinfection procedures pre- and post-intervention.

Behavior	Intervention			Control		
	Pre-intervention	Post-intervention	p-Value	Pre-intervention	Post-intervention	p- value
	Compliance Rate/Level	Compliance Rate/Level		Compliance Rate/Level	Compliance Rate/Level	
I wash my hands before handling my contact lenses	84.6 High	92.3 High	0.317	92.8 High	99.0 High	0.083
I use tap water or saliva to disinfect my lenses if no disinfection solution is available	95.2 High	96.2 High	0.408	96.9 High	97.9 High	0.063
I rub my lenses with solution on both sides each time I disinfect them	51.9 Moderate	77.9 Moderate	0.130	51.5 Moderate	80.4 High	**0.049***
I rinse my contact lenses with solution after the rubbing step	62.5 Moderate	76.0 Moderate	0.691	64.9 Moderate	82.5 High	0.259
I check my lenses for debris & damage before insertion	84.6 High	96.2 High	0.388	85.6 High	96.9 High	0.131
I use fresh disinfecting solution to store / soak my lenses after each use	70.2 Moderate	84.6 High	0.097	81.4 High	90.7 High	0.740
When I soak my contact lenses, I fill the lens case with enough fresh disinfecting solution to cover the lenses completely	93.3 High	96.2 High	0.257	92.8 High	94.8 High	0.096
I soak my contact lenses in the disinfecting solution for more than 4 Hrs every night	96.2 High	90.4 High	**0.010***	97.9 High	92.8 High	0.071

4.3.3 Category C: Care of Contact Lens Accessories

For the intervention group, as shown in Table 17, there was a significant improvement (p=0.00) in the compliance mean score from 3.5 pre-intervention to 4.14 post-intervention. The mean compliance score for all behaviors relating to care of contact lens accessories increased post-intervention, where five out of six behaviors had a statistically significant difference between pre- and post-intervention.

Table 17: Descriptive analysis for compliant behaviors related to care of contact lenses accessories for the intervention group

Behavior	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I clean my contact lens case well with antiseptic solution / soap and air-dry with the top off and the face down once a week.	Never	52.9	2.2	1.0	12.5	3.6	4.0	**0.00***
	Rarely	12.5			11.5			
	Sometimes	11.5			20.2			
	Often	8.70			19.2			
	Always	14.4			36.5			
I allow the lens case to air-dry with the top off and the face down after inserting my lenses each day	Never	67.3	1.6	1.0	27.9	2.8	3.0	**0.00***
	Rarely	13.5			21.2			
	Sometimes	8.70			16.3			
	Often	8.70			13.5			
	Always	1.90			21.2			
I replace the contact lens case every 3 months	Never	14.4	3.8	5.0	3.80	4.2	5.0	**0.016***
	Rarely	7.70			8.70			
	Sometimes	12.5			6.70			
	Often	10.6			25.0			
	Always	54.8			55.8			
I share my contact lens case with others (family members or friends)	Never	96.2	5.0	5.0	100.0	5.0	5.0	**0.046***
	Rarely	3.80			0.00			
	Sometimes	0.00			0.00			
	Often	0.00			0.00			
	Always	0.00			0.00			
I recap my solution bottle immediately after use	Never	1.00	4.8	5.0	0.00	4.9	5.0	0.115
	Rarely	1.90			0.00			
	Sometimes	1.90			1.90			
	Often	7.70			7.70			
	Always	87.5			90.4			
I always check the ‘discard-after’ dates of my contact lens solutions	Never	25.0	3.6	5.0	3.80	4.4	5.0	**0.00***
	Rarely	5.80			5.80			
	Sometimes	6.70			7.70			
	Often	9.60			8.70			
	Always	52.9			74.0			
ALL			**3.5**	**4.0**		**4.14**	**5.0**	**0.00**

For the control group, as shown in Table 18, the results indicated that there was a significant improvement in the mean compliance score from 3.49 pre-intervention to 4.17 post-intervention (p = 0.030). The mean compliance score improved post-intervention for all behaviors, however three out of six behaviors, had a significant difference between pre- and post- intervention (Wilcoxon signed ranks test, p<0.05), including adherence to cleaning contact lens case weekly (p =0.00), daily air-drying of contact lens case (p=0.00), and checking solution expiry date (p =0.016).

Table 18: Descriptive analysis for compliant behaviors related to care of contact lenses accessories for the control group.

Behavior	Answer	Pre-intervention			Post-intervention			p-Value
		%	Mean	Median	%	Mean	Median	
I clean my contact lens case well with antiseptic solution / soap and air-dry with the top off and the face down once a week.	Never	63.9	1.9	1.0	16.5	3.6	4.0	**0.0***
	Rarely	4.10			6.20			
	Sometimes	15.5			17.5			
	Often	8.20			24.7			
	Always	8.20			35.1			
I allow the lens case to air-dry with the top off and the face down after inserting my lenses each day	Never	78.4	1.6	1.0	20.6	3.1	3.0	**0.0***
	Rarely	4.10			16.5			
	Sometimes	6.20			18.6			
	Often	6.20			17.5			
	Always	5.20			26.8			
I replace the contact lens case every 3 months	Never	11.3	4.1	5.0	4.10	4.3	5.0	0.089
	Rarely	7.20			2.10			
	Sometimes	10.3			12.4			
	Often	7.20			18.6			
	Always	63.9			62.9			
I share my contact lens case with others (family members or friends)	Never	96.9	4.9	5.0	99.0	4.9	5.0	0.141
	Rarely	2.10			1.00			
	Sometimes	1.00			0.00			
	Often	0.00			0.00			
	Always	0.00			0.00			
I recap my solution bottle immediately after use	Never	2.10	4.8	5.0	1.00	4.8	5.0	0.596
	Rarely	0.00			0.00			
	Sometimes	4.10			3.10			
	Often	4.10			7.20			
	Always	89.7			88.7			
I always check the ‘discard-after’ dates of my contact lens solutions	Never	24.7	3.7	5.0	11.3	4.2	5.0	**0.006***
	Rarely	4.10			3.10			
	Sometimes	5.20			8.20			
	Often	6.20			9.30			
	Always	59.8			68.0			
All			**3.49**	**4.0**		**4.17**	**5.0**	**0.030**

Although the difference of means between pre-and post-intervention individually for the intervention and control group was significant depending on p-value as shown in Table 17, 18; confidence interval for the difference of means between pre-and post-intervention for both groups in the care of contact lens accessories were measured to check the significance of difference between the groups in the whole category. The results in Table 19 showed that the confidence interval is between (-80.7, -47.4) for the intervention group, and (-85.2, -51.1) for the control group. Hence, there is no difference between in the intervention group and the control because there is an intersect in the two confidence intervals as shown in Figure 8.

Table 19: The independent t-test for the care of contact lens accessories category

Participant type		**t-test for Equality of Means**						
							95% Confidence Interval of the Difference	
		T	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
Intervention	**Equal variances assumed**	-7.599-	206	.000	-.64103-	.08436	-.80734-	-.47472-
	Equal variances not assumed	-7.599-	205.338	.000	-.64103-	.08436	-.80734-	-.47471-
Control	**Equal variances assumed**	-7.879-	192	.000	-.68213-	.08657	-.85289-	-.51137-
	Equal variances not assumed	-7.879-	190.986	.000	-.68213-	.08657	-.85289-	-.51137-

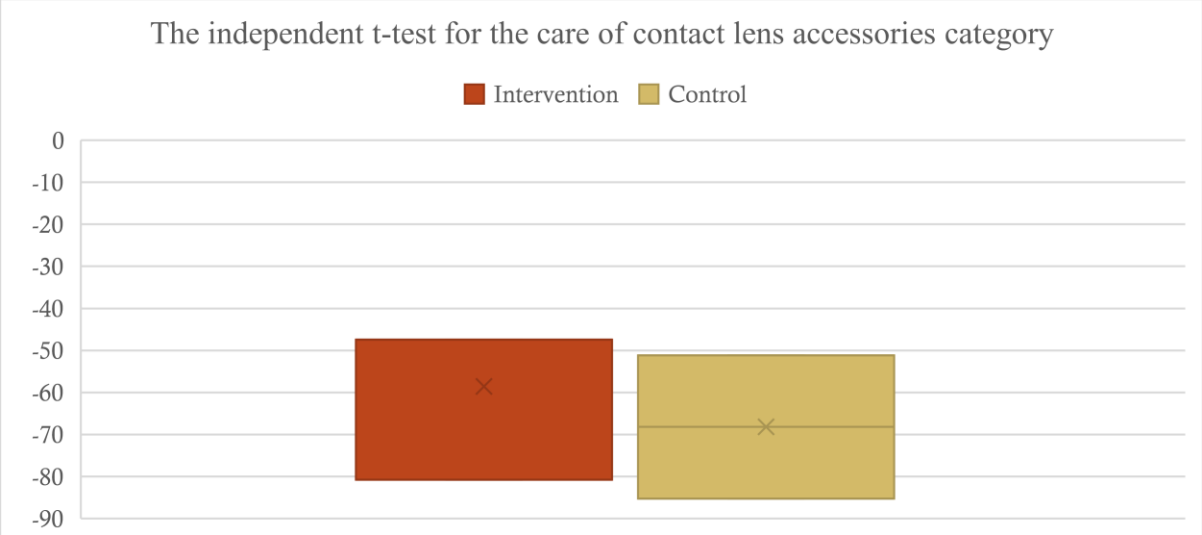

Figure 8: The intersection in the confidence intervals of the difference of means between the intervention and the control group in the care of accessories category.

Non-compliance to adequate behaviors relating to care of contact lens accessories was more prominent, as shown in Table 20, but for both the intervention and the control groups, the compliance rate was improved post-intervention. As far as weekly cleaning of the contact lens case, the intervention group compliance rate improved from 23.1% pre-intervention to 55.8% post-intervention with a statistical significance of (p=0.00), while for the control group, the compliance rate improved from 16.5% pre-intervention to 59.8% post-intervention (p=0.00). Pre-intervention, only 10.6% of participants in the intervention group, and 11.3% of participants in the control group adhered to daily cleaning and air drying of the contact lens case, and this improved to 34.6% (p=0.903) and 44.3% (p=0.00) respectively post-intervention. The statistically significant improvement in the compliance rate was found only in two behaviors in the intervention group including weekly cleaning of the contact lens case and checking solution expiry dates. As for the control group the statistically significant improvement was also found in two behaviors including cleaning contact lens case weekly and daily air-drying of contact lens case.

Table 20: The compliance rate for the care of contact lenses accessories pre- and post-intervention.

Behavior	Intervention			Control		
	Pre-intervention	Post-intervention	p-value	Pre-intervention	Post-intervention	p-value
	Compliance Rate/Level	Compliance Rate/Level		Compliance Rate/Level	Compliance Rate/Level	
I clean my contact lens case well with antiseptic solution / soap and air-dry with the top off and the face down once a week.	23.1 Low	55.8 Moderate	**0.000***	16.5 Low	59.8 Moderate	**0.000***
I allow the lens case to air-dry with the top off and the face down after inserting my lenses each day	10.6 Low	34.6 Low	0.903	11.3 Low	44.3 Moderate	**0.000***
I replace the contact lens case every 3 months	65.4 Moderate	80.8 High	0.317	71.1 Moderate	81.4 High	0.427
I share my contact lens case with others (family members or friends)	100.0 High	100.0 High	1.000	96.9 High	100.0 High	0.317
I recap my solution bottle immediately after use	95.2 High	98.1 High	0.409	93.8 High	95.9 High	0.157
I always check the 'discard-after' dates of my contact lens solutions	62.5 Moderate	82.7 High	**0.000***	66.0 Moderate	77.3 Moderate	0.167

4.4 The Level of Compliance

There was an overall improvement in the level of compliance for the total sample size for both the intervention and control groups, as presented in Table 21. The overall compliance rate improved from 45.3% pre-intervention to 80.6% post-intervention. A decrease in the overall non-compliance rate was reported to be 54.7% pre-intervention and 19.4% post-intervention. Post-intervention, there were only 39 non- complaint participants, who received a compliance score <4, while there were 162 complaint participants with a compliance score is ≥4.

Figure 9 displays the level of compliance among soft contact lens wearers in this study.

Table 21: The level of compliance among Palestinian soft contact wearer.

Compliance Level	Total Study Sample (Intervention and Control)			
	Pre-intervention		Post-intervention	
	Number (N=)	Percentage (%)	Number (N=)	Percentage (%)
Non-compliance	110	54.7%	39	19.4%
Compliance	91	45.3%	162	80.6%
Total	**201**	**100.0%**	**201**	**100.0%**

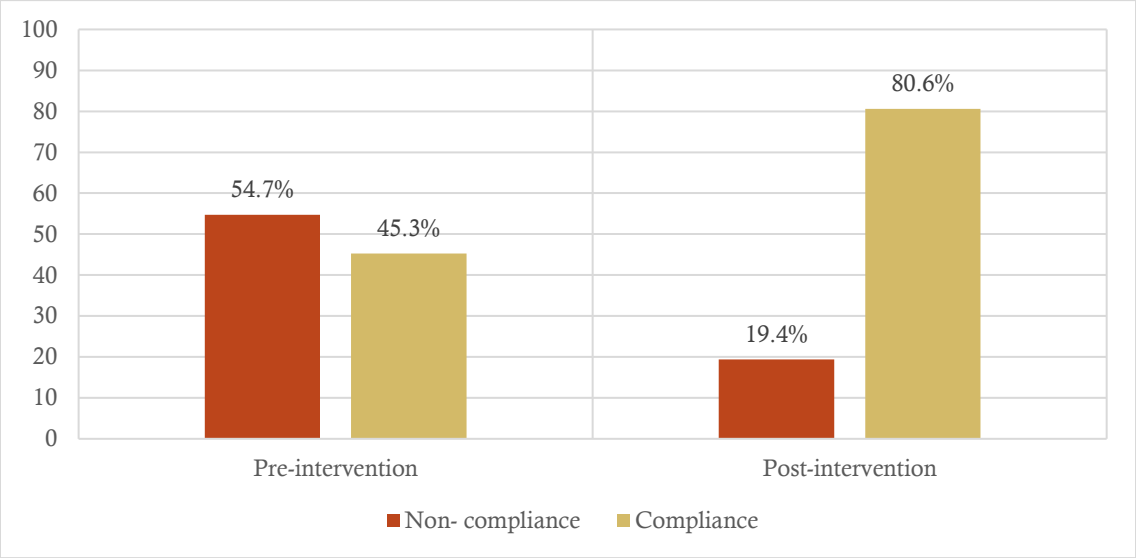

Figure 9: The overall level of compliance among soft contact lens wearers

4.5 Relationship Between the Level of Compliance and Study Variables

4.5.1 The Level of Compliance & Demographics

For age and level of education, the Kruskal-Wallis Test was conducted to assess the relationship with the level of compliance and the results showed that there is no significant relationship between the level of compliance and age pre-intervention (p=0.279) and post-intervention (p=0.377). A significant relationship was found between the level of compliance post-intervention and the level of education for diploma degree holders (p=0.047).

4.5.2 Level of Compliance with Contact Lens History

The Kruskal-Wallis Test was utilized to assess the relationship between contact lens wearing history and type of contact lenses with the level of compliance. The results showed there was no significant relationship between level of compliance and lens wearing history pre-intervention (p=0.442) and post-intervention (p=0.597). For the type of contact lens, the results showed that there is no significant relationship between the level of compliance and the type of contact lenses worn pre-intervention (p=0.082), and post-intervention (p=0.714). The Mann- Whitney U Test was utilized to assess the relationship between the level of compliance and modality of contact lens wear and no significant relationship was found pre-intervention (p-value=0.882) or post-intervention (p=0.999).

4.6 The Effect of The Enhancement Strategy on Compliance Behaviors

To compare whether the enhancement strategy (mHealth app) was effective in improving the compliance and behaviors of soft contact lens wearers among participants in the intervention and the control groups, the Mann Whitney U Test was utilized. Our statistical analysis revealed that only one behavior, (adherence to recommended daily wearing time), had a significant change in the level of compliance between the intervention and control groups post-intervention (p-value = 0.03). As shown in Table 22, when comparing the mean rank there were no significant differences between intervention and control groups in all other behaviors relating to wearing and replacement habits, disinfection procedure, and care of contact lens accessories.

Table 22: Compliance scores for contact lens wear and care behaviors for the intervention and control groups

Behavior	Mean Rank		*P*-Value
	Case	Control	
Wearing and replacement habits			
I WEAR my lenses as per the recommended wearing time each day (not more than 8 -12 hours)	108.93	93.61	**0.03***
I DISCARD my used contact lenses and switch to a new pair as recommended	98.50	103.68	0.47
I do NAP (sleeping for short periods) in my contact lenses	97.44	104.81	0.23
I sleep OVERNIGHT in my contact lenses	101.10	100.90	0.93
If my eyes look RED OR IRRITATED, I remove my lenses as soon as possible	99.34	102.78	0.49
I ATTEND all the recommended after-care visits suggested by my practitioner	102.73	99.15	0.65
Disinfection procedures			
I WASH my hands before handling my contact lenses	98.68	103.48	0.36
I use TAP WATER or saliva to disinfect my lenses if no disinfection solution is available	100.59	101.44	0.74
I RUB my lenses with solution on both sides each time I disinfect them	101.53	100.43	0.88
I RINSE my contact lenses with solution after the rubbing step	102.25	99.66	0.72
I CHECK my lenses for debris & damage before insertion	99.66	102.44	0.61
I use FRESH disinfecting solution to store / soak my lenses after each use	98.69	103.47	0.48
When I soak my contact lenses, I FILL the lens case with enough fresh disinfecting solution to cover the lenses completely	102.88	98.98	0.41
I SOAK my contact lenses in the disinfecting solution for more than 4 Hrs every night	98.58	103.59	0.33
Care of contact lens accessories			
I CLEAN my contact lens CASE well with antiseptic solution / soap and air-dry with the top off and the face down once a week.	100.89	101.12	0.97
I allow the lens case to AIR-DRY with the top off and the face down after inserting my lenses each day	94.75	107.70	0.11
I REPLACE the contact lens case every 3 months	97.65	104.59	0.34
I SHARE my contact lens case with my others (family members or friends)	101.50	100.46	0.3
I RECAP my solution bottle immediately after use	101.93	100.00	0.65
I always CHECK the ‘discard-after’ dates of my contact lens solutions	104.50	97.25	0.27

Chapter Five: Discussion

This study aimed to assess the effectiveness of mHealth app (LENSA) on the compliance and behavior of soft contact wearers in the oPt, and to compare the level of compliance between the intervention and control groups. LENSA app was effective in improving only one behavior relating to daily wearing time of contact lenses (*p*-value=0.030). This could be related to the reminder feature in the app that sends user notifications to remove contact lenses after 8 hours. The results showed that there was some degree of compliance in contact lenses wearing and replacement behaviors, disinfection procedures, and care of accessories for both groups pre- intervention, and this good compliance may relate to the pandemic which improved the general hygienic behaviors that could be reflected on contact lenses wearers behaviors.(Bakkar & Alzghoul, 2021; Vianya-Estopa et al., 2021) The compliance rates improved at different rates post-intervention for both groups in various behaviors of contact lens wear and care categories.

5.1 Compliance Assessment Technique and Enhancement Strategy

A combination of face-to-face, electronic and telephone-based questionnaire was the technique utilized to assess the compliance level, which was similar to techniques used in published literature.(Claydon & Efron, 1994a; COLLINS & CARNEY, 1986; Ky et al., 1998) Our literature review indicates that many studies utilized Yes/No close-ended questionnaires that focused on whether participants performed the contact lens care procedures or not. In this study, the Likert-scale was utilized to specify the frequency of performing behaviors, and this has increased the sensitivity of the questionnaire. This could be why our results indicated that

participants had much better initial compliance during the pre-intervention in comparison to other studies.

The mHealth app in combination with written instructions was the enhancement strategy used on the intervention group for the duration of the study. At the end of the study, compliance was re-assessed using the same pre-intervention questionnaire. Booklets, posters, videos, checklists, and health care contracts were used by previous studies as enhancement strategies, but the results indicated that no significant change in the level of compliance was accomplished through these techniques.(Claydon et al., 1997) A case-control study that utilized a self-review exercise and microbial assessment for the lenses and accessories as an enhancement strategy, indicated a significant change in only in one health care behavior in the case group. The authors reported that the level of compliance for both groups were improved along the study and this improvement was related to regular after care visits and continuous review of lens care procedures.(A. M. S. Yung et al., 2007)

5.2 Demographical Profile

In the current study, the majority of participants were females (91.5%), which is consistent with a study conducted in Jordan and this might be related to fact that in the middle-east, there is a stigma regarding wearing glasses especially among females, this we see more females willing to wear contact lenses.(Bakkar & Alzghoul, 2020) While other studies reported a ratio of 3 females to 1 male, and a ratio of two female to one male were wearing contact lenses. (Gyawali et al., 2014; Sapkota, 2015; A. M. S. Yung et al., 2007) The relationship between the level of compliance and gender in our study was not assessed due to the gap in male to female ratio, where a limited number of male participants were reported, and this would likely weaken any true association between compliance and gender.(Bakkar & Alzghoul, 2020; Noushad et al., 2012; Sapkota, 2015;

Yeung et al., 2010a) However, Morgan P. et al in their international analysis for contact lens wearers' compliance in 14 countries, stated that gender was a predictive factor for non-compliant behaviors with better compliance reported for females compared to males.(Morgan et al., 2011a) The average age of contact lens wearers in this study was 27.4±7.38 years, where 49.8% of participants were within the age group of 16-25 years. This is similar to Bakkar M. et al study population of university students where 86.7% of participants were between 18-25 years,(Bakkar & Alzghoul, 2020) and Noushed B. et al study population which was also conducted among university students between 18-22 years of age.(Noushad et al., 2012) The high number of participants in this age group is related to their believe that contact lenses boost self-esteem, and they often feel more accepted without spectacles, in addition to their motivation to enhance their appearance.(Abokyi et al., 2017; Irfan et al., 2019) In our study, there was no relationship between the level of compliance and participants' age, which is consistent with literature.(Sapkota, 2015) One study reported that contact lens wearers of collage age (15-25 years) were more likely to be non-compliant. Non-compliance in this age group was related to lack of family supervision, unavailability of money to purchase new lenses and care supplies, and unawareness of risks associated with non-compliance behaviors.(Hickson-Curran et al., 2011)

Although our results indicated a significant relationship between the level of compliance and the level of education, the number of participants in our study who were non-educated was too small (n= 2.5%) to draw any conclusions regarding this. Results reported in other studies did not find any significant relationship between the level of compliance and the level of education.(Janti et al., 2014; Kumar Chattu, 2013)

Similar to other studies, there was no relationship between the level of compliance and contact lens related history including total duration of contact lens wear, modality of contact lens wear,

and type of contact lenses worn.(Pradhan et al., 2017; Sapkota, 2015) On the other hand, Chun and Weissman reported that people with experience in contact lens wear were more likely to be non-compliant as they have already established bad habits.(CHUN & WEISSMAN, 1987)

Smoking, hyperopia, online supply of contact lenses, have been reported to be associated with non- compliance and ocular complications in other studies, but they were not assessed in this study.

5.3 Contact Lens Wear and Care Behaviors That Influence the Level of Compliance

The average level of compliance for the total study sample was improved post-intervention from 45.3% to 80.6%. The literature highlighted that the percentage of compliant participants is highly dependent on the method of assessment and the criteria used to define non-compliance.(A. M. S. Yung et al., 2007)Some studies defined non-compliance as failing to adhere to any one of the lens care and wear behaviors, (COLLINS & CARNEY, 1986) And if this definition is applied in this study, all the participants would be non-compliant. Thus, to obtain a more realistic assessment of the compliance rate in our study, the total number of participants who answered (always) or (often) to the wear and care behavior questions was determined and considered to be high compliance. In the current study, low to high compliance was reported across the various care and wear behaviors assessed pre-intervention, with a range of compliance rate from 10.6% to 100% in both the control and intervention groups. Post-intervention, the rate of compliance improved with a range of 34.6% to 100% in both groups. The improvement in the rate of compliance in the control groups is likely due to the fact that they received verbal instructions on healthy wear and care behaviors, while the improvement reported in the intervention group is likely due to the use of LENSA app with its features that remind participants of specific wear and care behaviors, in addition to the written instructions they received pre-intervention.

5.3.1 Wearing and Replacement Habits

This section including wearing and replacement habits that were discussed as following order: contact lens daily wearing hours, manufacturer recommended replacement frequency, contact lens over wear, and aftercare visits.

Contact Lens Daily Wearing Hours

In the intervention group, there was a moderate compliance with the recommended daily wearing hours pre-intervention, which improved to high compliance post-intervention. While the compliance level was considered high in pre- and post- intervention for the control group. The recommended daily wearing hours is usually determined by the clinician and is dependent on the ocular health status of the patient and their tolerated comfort level. It is not surprising that most participants have a high compliance to the recommended daily wearing hours, as most patients usually wear their contact lenses during waking hours for at least 12 hours.(Johnson A, 2020)Compliance to daily wearing hours varies in literature. A study conducted in Turkey reported that 54% of lay people were compliant with the recommended hours of daily wear, while a 77% compliance rate was reported in India, and 81% rate was reported in Australia.(Noushad et al., 2012; Taslipinar Uzel et al., 2018; Y. Wu, Carnt, & Stapleton, 2010)

Manufacturer Recommended Replacement Frequency

Our results showed that the participants in the intervention and control groups, were moderately compliant with discarding contact lenses and switching to new ones as recommended in the pre-intervention. This improved to high compliance level in the post-intervention for the both groups. This was different to what was reported by a similar study, where there was an improvement in adhering to replacement schedule from 77% to 83% for the control group, but compliance decreased from 80% to 73% in the intervention group. The authors revealed this decrease in the

level of compliance post-intervention was due to the fact that the majority of participants were established contact lens wearers who already developed bad habits. Non-compliance with MRRF was reported more in patients who use bi-weekly and monthly contact lenses, compared to those who purchased an annual supply of contact lenses or who use daily disposable contact lenses.(Dumbleton et al., 2013; Hickson-Curran et al., 2011; Yeung et al., 2010a) Several reasons have been reported by users who do not adhere to the MRRF, including lack of awareness, forgetfulness about replacement date, and finally for some, frequent replacement may be something they cannot afford, or are not willing to pay for.(Yeung et al., 2010a) To improve contact lens wearers compliance with MRRF, practitioners may suggest to purchase an annual supply of contact lenses at a discount. Strong recommendations combined with written instructions and reinforcement at each after-care visit, in addition to providing a reminder service are additional suggestions that may be utilized by practitioners to improve compliance with MRRF. (Dumbleton et al., 2013; Hickson-Curran et al., 2011)

Contact Lens Over-Wear

High level of compliance was reported among participants for not napping in their contact lenses in pre-and post-intervention. Additionally, participants were highly compliant with not sleeping overnight with contact lenses in pre- and post-intervention for both the intervention and the control groups. The compliance rates of contact lens over-wear varied in the literature among countries, where low to high levels of compliance was reported, depending on the target population, and the type of contact lenses used. High compliance was reported in studies conducted in Jordan,(Bakkar & Alzghoul, 2020) India(Noushad et al., 2012) and Saudi Arabia,(Ibrahim et al., 2018) while moderate compliance was reported in Australia, and Maldives.(Gyawali et al., 2014; Y. Wu, Carnt, & Stapleton, 2010) This high compliance reported was attributed to written educational

material provided to patients and high awareness of the severe complications associated with overnight sleeping with contact lenses.(Bakkar & Alzghoul, 2020; Noushad et al., 2012) A study conducted in the United States of America showed that 87.1% of participants reported napping with contact lenses (low compliance), while 50.2% reported sleeping overnight with contact lenses (moderate compliance), and this was attributed to mis-understanding that any type of contact lenses is approved for overnight wear, despite the fact that only specific types of soft and rigid lenses have been approved for overnight wear by Food and Drug Administration.(Cope et al., 2016)

After Care Visits

Generally, there was a low compliance in adherence to aftercare visits in both groups, however it was remarkable for the control group. In the intervention groups about half of participants reported they never told about follow up visits, while for the control group about two third of participants reported that they never told about follow up appointment's pre-intervention, which explained the high non-compliance level in this behavior. The increase in the rate of compliance was related to increased awareness on the importance of aftercare visits during the initial interview for both groups. The initial low non-compliance rate reported by participants in both groups is likely due to the lack of implementation of follow-up protocols and appointments by optometrists. Clear guidelines and protocols about proper follow-up care must be adopted by the Palestinian Optometric Association and practitioners must be encouraged to utilize HIS that can assist in keeping up with follow up appointments. Another method proposed in a report to enhance adherence to follow up care is the use of video call appointments, which was initially used during COVID pandemic, to follow up with patients regarding their comfort level and to ensure no red

flag symptoms are reported. In addition to confirm the instructions and recommendations related to contact lens care and wear.(Naroo et al., 2021)

These results were consistent with previous studies which reported that adherence to after care visits is the most ignored behavior by contact lens wearers.(Bakkar & Alzghoul, 2020; Gyawali et al., 2014; Jun et al., 2018) The stated reasons for low compliance in this behavior were forgetting the appointment, being busy to attend aftercare visits, no need since the eyes seem healthy, and/or never been told about follow up appointments.(Bakkar & Alzghoul, 2020; Gyawali et al., 2014) In addition to online shopping that is reported recently in literature as a reason for non-compliance with after care visits, as it provided contact lenses wearers with a wide variety of contact lens products, special offers and convenience.(Thite, 2015)

5.3.2 Disinfection Procedures

This section discussing the disinfection procedures in the following order: hands hygiene, water and saliva exposure, and contact lens disinfection process.

Hands Hygiene

This behavior was considered of high compliance for both groups in pre- and post-intervention. This is might be related to COVID-19 pandemic, which has played a role in enhancing general hygiene, especially with the continuous WHO recommendations on the importance of washing hands and regular disinfection. This high compliance was also seen in a study conducted during the pandemic, where the authors attributed that to improved awareness among participants on the importance of handwashing to reduce contacting COVID-19.(Vianya-Estopa et al., 2021) The high compliance rate could also be due to the fact that our questionnaire did not specify the agent used for hand washing (soap or antiseptic). Yung A. et.al. reported that both the control and intervention groups in their study had an increase in compliance for hand washing with soap after

12 months of study. Universally, the range of hand hygiene compliance rate is 14-50%,(Radford et al., 1993; Sokol et al., 2010; Y. Wu, Carnt, & Stapleton, 2010; A. M. S. Yung et al., 2007) and this large variation is related to the way the question was phrased and whether the hand washing agent was specified or not.(Gyawali et al., 2014; Y. Wu, Carnt, & Stapleton, 2010) Non- compliance with hand washing is considered a modifiable risk factor for prevention of microbial keratitis and case contamination. Therefore, providing proper teaching of hand washing techniques using soap that covers all hand surface for a time duration of 15 seconds, or 30s, or 60s is essential to prevent contact-lens related infections.(McMonnies, 2012)

Water and Saliva Exposure

Participants in our study were well aware not to clean contact lenses with water or saliva. Therefore, the compliance rate was high for both the intervention and control groups pre-and post-intervention. The majority of participants who reported using water to clean contact lenses stated that they only did that when they ran out of their disinfection solution. Multiple studies reported high compliance in not using water or saliva to clean contact lenses.(Bakkar & Alzghoul, 2020; Ky et al., 1998; Yeung et al., 2010a) Inability to afford new contact lens solution, or unawareness of the seriousness of water exposure to contact lenses are some of the reasons reported by contact lens wearers who were not compliant in this behavior.(Shamiso G. GWATA, 2017)

Contact Lens Disinfection Process

Rubbing, rinsing and soaking contact lenses with fresh disinfecting solution each time the lenses are used, is a mandatory 3-steps process, and according to recommendations, no step should be missed. In our study, the compliance rate was moderate for the intervention group pre-intervention, in rubbing, rinsing and soaking with fresh disinfection solution. While the rate of compliance improved post-intervention, rubbing and rinsing behaviors remained within moderate

compliance range, while soaking behaviors improved to high compliance range. As for the control group, rubbing and rinsing were of a moderate compliance pre-intervention and improved to high compliance post-intervention, while soaking behavior was of high compliance pre- and post-intervention. Bakkar et al reported that only 55.7% of participants were compliant in adherence to contact lenses disinfection procedure (rubbing, rinsing, soaking) which was considered to be moderate compliance level.(Bakkar & Alzghoul, 2020) Similarly, Yung et al reported that the compliance rate in the intervention group pre- intervention for the rubbing and rinsing steps was 60% and 80%, and improved to 83% and 93%, respectively.(A. M. S. Yung et al., 2007) While for the control group, the compliance rate of cleaning and rinsing was 70% and 83% and improved to 77% and 93% respectively.

Checking contact lenses for debris or damage and filling contact lens storage case with enough disinfection solution was of high compliance for both groups, pre- and post-intervention in our study. Most of contact lens wearers checked contact lenses prior to wear to see if the lens is reversed or not, and to remove any attached debris or damage. This differs from another study who found that the compliance towards this behavior was moderate among Indian university students.(Noushad et al., 2012)Soaking contact lenses with disinfection solution at least 4 hours every night had a statistically significant decrease for both groups in pre- and post-intervention. It is unclear why this decrease in compliance occurred. It may be due to the fact that many participants did not understand the question, or clicked on the wrong answer, as many of the post-intervention questionnaires were collected through online forms due to COVID-19 restrictions.

5.3.3 Care of Contact Lens Accessories

Contact lens storage cases are a risky source of microbial contamination that can be easily transmitted to the lenses and eyes if not disinfected and replaced regularly. Therefore, the importance of lens case replacement regularly, and disinfection on a daily and weekly basis must be emphasized to all contact lens wearers.(Gray et al., 1995; Y. T. Wu et al., 2010)

This section discussing the care of contact lens accessories category as follows: contact lens case disinfection, sharing storage case with others, case replacement and care of contact lens solution.

Contact Lens Storage Case Disinfection

Pre-intervention, a low compliance rate was reported in both the intervention and the control groups for weekly and daily cleaning of storage cases with air drying. For the intervention group, the compliance rate improved post-intervention for daily cleaning, but remain within low compliance range (<40%), as for weekly cleaning it improved to moderate compliance level post-intervention. While for the control group, both daily and weekly cleaning of contact lens care storage were improved from low compliance to moderate compliance. Similar results were reported in another case-control study, where improvement was contributed to the set of instructions that were given to participants regarding case hygiene.(A. M. S. Yung et al., 2007)

In Palestine, there is a significant gap in patient education on lens care and wear, and the majority of optometrists do not provide patients with clear instructions, especially regarding contact lens storage case hygiene. In literature, authors reported that contact lens wearers compliance with storage case hygiene was affected by the lack of standard instructions and contradicting messages from the manufacturers and practitioners. Thus, it is essential to create a standardized guideline that must be provided to each contact lens wearer to improve lens case hygiene compliance.(Y. Wu, Carnt, & Stapleton, 2010; Y. Wu, Carnt, Willcox, et al., 2010)

Sharing Storage Case with Others, Case Replacement and Care of Contact Lens Solution

Compliance to contact lens storage case replacement improved from moderate to high compliance level for both the intervention and control groups. Of those participants in our study who exhibited high compliance to lens case replacement, mentioned replacing case with every newly purchased disinfection solution. Participants who reported low and moderate compliance were unaware of case replacement frequency, or were never told to replace it every 3-months. The compliance in case replacement varied in literature from low to moderate compliance rate and that was attributed to lack of awareness of contact lens wearers regarding the importance of case replacement.(Bakkar & Alzghoul, 2020; Hickson-Curran et al., 2011; Sapkota, 2015; A. M. S. Yung et al., 2007) To prevent non-compliance behaviors related to case hygiene and replacement, some authors propose switching users to daily disposable contact lenses.(Taslipinar Uzel et al., 2018)

High compliance was reported in both the intervention and the control groups for not sharing contact lens cases with others and for recapping contact lens solution bottles, pre-intervention and post intervention, and similar results were also reported in other studies.(Bakkar & Alzghoul, 2020; COLLINS & CARNEY, 1986; Ky et al., 1998; Noushad et al., 2012) For checking the expiry dates of contact lens disinfection solutions, there was a statistically significant improvement in compliance rate for the intervention group from moderate compliance to high compliance. Yung et al also reported improvement in checking expiration dates for solutions, where compliance rate was improved from 50% pre-intervention, to 63% post-intervention (moderate compliance).(A. M. S. Yung et al., 2007) In our study, some of the participants were not aware that contact lens solutions must be discarded after 90 days of opening, and those who were compliant with this behavior were either aware of this fact or they use small sized solution, which would be discarded after a month or less of opening it.

5.4 Compliance Scores Post-Intervention

There was a statistically significant increase in the compliance scores of the participants in the intervention group in fourteen out of twenty lens care behaviors. The distribution of these behaviors is as follows: three behaviors in wearing and replacement habits, six behaviors in disinfection procedures, and five behaviors in care of accessories. While for the control group, there was a statistically significant increase in the compliance scores in eight out of twenty lens care behaviors. Those behaviors were distributed as follows: two behaviors in wearing and replacement habits category, three behaviors in disinfection procedures, and three behaviors in care of accessories category. Yung et al reported that six out of fifteen lens care procedures had a significant improvement in compliance scores after twelve months of intervention, and they attributed this to the continuous process of reviewing of healthy behaviors during the study period.(A. M. S. Yung et al., 2007)

5.5 Effectiveness of Compliance Enhancement Strategy

LENSA mHealth app was selected as our compliance enhancement strategy, in combination with written instructions. The app allowed participants to respond directly through subsequent notifications that were sent every 8 hours to remind users of contact lens removal, expiry dates, and to remind them to activate contact lens wearing button when users forgot to press the button of activation. It also helped to ensure that participants had reviewed and performed the whole list and instructions of lens care procedures carefully. The app was user friendly, as it was convenient for all mobile users regardless of their age or educational level, and was supported in both Arabic and English languages.

When the mean compliance scores were compared between both groups, a statistically significant difference was reported for only one lens care behavior, the ‘daily wearing time of contact lenses’

(*p- value* = 0.03) and only for the intervention group, and this could be due to the use of the enhancement strategy which sent daily reminders to users to remove their contact lenses after 8 hours of wear. As for the level of compliance for both groups, there was a clear improvement over the period of the study for the majority of lens care behaviors. Although no studies were found in literature that utilized mHealth apps to assess compliance to lens care behaviors, similar studies in health care were conducted to evaluate effectiveness of mHealth apps in improving health care behaviors. Glynn LG. et al. reported that the utilized mHealth app to improve daily physical activity was effective in only one measure (daily steps), and there was no significant change in other variables, and this was justified by authors to be related to the sleep mode in smartphones that could pause the application, thus making errors in entry of other variables.(Glynn et al., 2014) Borgen et.al. conducted a study to assess the effect of mobile app (pregnant+ app) on pregnant women with gestational diabetes mellitus, and they found that the app had no significant change on the blood glucose level for both the intervention and control groups, but it helped reduce the rate of caesarean section for both groups. They reported the major cause of no significant change in the blood glucose levels is that only two third of the pregnant women have completed measuring 2-hour blood glucose levels postpartum.(Borgen et al., 2019) Although these apps had no, or limited significant change on the studied variables, both studies agreed that using mHealth apps were a useful tool to change human behaviors positively, and can manage diseases such as gestational diabetes. Such inexpensive, user friendly technologies are currently being assessed as a component in future interventions to manage disease and promote physical activity in primary care.(Borgen et al., 2019; Glynn et al., 2014)

Two methods were utilized in this study to provide patients with instructions on proper lens care and wear behaviors in an effort to improve compliance among soft contact lens wearers. The first

method is the standard method using verbal instructions, and the second method is utilizing written instructions combined with the mHealth app. According to our results, there was no significant difference between the two methods utilized in the study. An overall improvement in compliance level was reported for the majority of lens care behaviors in both groups. It is unclear whether this lack of significance is due to the fact that the intervention group may not have been compliant with the use of the mHealth app, as the developers of the app have no way of tracking whether app users have been actually using the app on a daily basis. We believe that creating a standardized guideline of the healthy contact lens wear and care behaviors, and encouraging practitioners to implement it in their optometry centers either verbally, written or through mHealth apps, will have an impact in changing contact lens wearer compliance positively. That was confirmed in our findings that the two methods that were used, showed an improvement in the level of compliance for the intervention and control group with a similar rate.

5.5 Study Limitations

Limitations Related to The Methods

Quasi-experiment study design was selected as opposed to a randomized controlled trial, due to poor response from local optometry centers to enroll in the study, which ultimately limited the number of soft contact lens wearers among the target population and prevented us from utilizing random assignment. To overcome non-randomization, we used a comparable/ matched control group. Additionally, no validated questionnaires have been developed to assess compliance among contact lens wearers, and the development of our questionnaire relied on previous non-validated questionnaires that have been published in literature, and on our research team's clinical expertise.

Limitations Related to Excluding Daily Disposable Contact Lens Wearers

We did not look at daily disposable contact lens wearers as we assumed that all daily disposable wearers were compliant with the instructions related to daily replacement, however, various studies showed that daily disposable wearers were re-using their contact lenses in contrast to what they were instructed.(Boost et al., 2011; Dumbleton et al., 2009, 2010, 2013; Livi et al., 2017; Yeung et al., 2010b) The assessment of daily disposable contact lenses wearers compliance is a must and should be included in the future studies.

Limitations Related to COVID-19

The COVID-19 pandemic had major effect on the study, especially as the data collection was during the multiple lockdowns and movement restrictions that were implemented by the Palestinian government. During this period, optometry centers saw a major decline in the number of patients making appointments for contact lens fittings. Many patients during this period either discontinued their contact lens wear, or purchased their contact lenses through online vendors. Many of our study participants during the data collection period refused to conduct face-to-face interviews and they preferred phone or online interviews. To overcome this decline in the number of contact lenses wearers, and the poor response of other optometry centers to enroll in the study, the data collection team in Ramallah relied on recruiting participants to enroll by phone through the HIS at Tarifi Optometry Centers, and enrolling optical centers from various cities in the West Bank.

mHealth App Limitations

The LESA app, to this date, has not been scientifically validated as tool to assess compliance, but since the application was in Arabic language, our study team thought it is the most appropriate app to be used for our population. In addition, the application was updated during the data collection period to add new features, and all participants in the intervention group where texted through

WhatsApp to ensure that the application was still active and there were no technical difficulties. Only participants who used (Xiaome) brand encountered a problem that the application did not send notifications, and this was solved by deleting and re-downloading the application. In addition, if the app user ignored the notifications for several days, the app will stop sending notifications, and this would have affected participants' compliance to using the app.

5.6 Recommendations

The Palestinian Optometric Association should implement standardized protocol for the provision of instructions regarding contact lens care and behaviors among local practitioners, as it is clear that even the simple verbal instructions can improve patient compliance. mHealth apps can help contact lens wearers to control their wearing hours, and over wear of contact lenses, and could be a useful tool for the millennials who are more tech savvy. Furthermore, protocols should be implemented for all eye care practitioners to schedule aftercare visits for all contact lens wearers either newly or established, to avoid occurrence of ocular complications related to contact lens wear, and to continually review healthy behaviors at each visit. This can be achieved through the use of HIS, which is not widely utilized among eye care practitioners locally, as well as the use of video calls to follow up with patients after cataract lenses have been dispensed.

On a local level, the Palestinian Optometric Association, in collaboration with the Ministry of Health, should implement official regulations to control un-authorized selling of contact lenses, whether it is through online stores or through other non-optometric vendors.

In order to encourage contact lens users and practitioners at optometry centers to use the mHealth apps, a suggestion will be provided to the LENSA developer to add a feature that will be used to locate the nearest optometry center. This feature would allow the app users to locate the nearest optometry center through the Global Positioning System (GPS), to book an appointment or to order

contact lenses online through social medias (phone number, WhatsApp, Facebook, Instagram). This suggestion may take time to be implemented, but the mHealth app industry is a fast-growing technology that can innovate new solutions to improve health care and patients' behaviors.

5.7 Future Studies

Further studies are needed to assess the effectiveness of mHealth app for longer periods of time and using a larger study sample. We propose to conduct a national study that includes all optometry centers in Palestine to assess the compliance of contact lens wearers wearing all contact lens modalities (daily disposable, soft, rigid, scleral, and hybrid), and evaluate association with additional variables that were not included in our study (smoking, place of purchasing, and type of refractive error). As for the application validity, a future study could be conducted to assess whether LENSA is a useful tool to improve the awareness and the compliance of contact lens wearers, and to conduct comparative study between LENSA and other apps.

5.8 Conclusion

This study is the first study in Palestine to assess the effectiveness of mHealth app on the compliance and behavior of soft contact lens wearers. The current study showed low to high level of compliance among the assessed lens care behaviors. The rate of compliance for those behaviors were improved after implementing the enhancement strategy combined with written instructions for the intervention group, and providing verbal instructions to the control group. The results illustrated that the majority of contact lens wearers in both groups showed high level of compliance in various behaviors pre-intervention. However, participants had low compliance levels in the cleaning of contact lens storage case and in adhering to aftercare visits in both groups. The LENSA app had a significant effect in only one behavior out of twenty that have been assessed pre- and

post-intervention. The level of compliance was measured for contact lens wearers, and the relationship with demographical variables, and contact lens wearing variables were assessed, and there was a significant relationship between the level of compliance and level of education, and no relationship with other variables.

Overall, the level of compliance in contact lens care and wear behaviors for contact lens wearers in Palestine was similar to other studies reported in literature. Although there was no difference between the instructions delivered through enhancement strategy/written instructions and the standard verbal instructions, LENSA app confirmed its effectiveness in controlling daily wearing hours with a significant difference between intervention and control groups, in addition to the improvement in the compliance level of other behaviors. mHealth app can be a useful tool for contact lens wearer and will enable them to control daily wearing hours, manufacturer recommended replacement frequency, in addition to access to educational materials regarding lens wear and care.

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Appendices

Appendix 1

Questionnaire

Effectiveness of mobile application use on compliance and behavior of soft contact lens wearers in the Occupied Palestinian Territories

For Clinician Only

SCL brand		**Manufacturer Replacement Frequency**	
Questionnaire type	□ Pre-intervention □ Post-intervention		

Interview Questions

1)Demographic Data		**2) Contact Lens History**	
Participant Code Initials, DOB, Age e.g. AS24111991	□ Specify:	**(5) Total lens wearing history (years)**	□ ≤ 6 months □ 6months- 2years □ >2 years- 4years □ > 4 years
Participant Phone #	□ Specify:	**(6)Type of soft contact lenses**	□ Corrective (Prescription) □ Colored (No prescription) □ Corrective with color (Prescription)
Group number Participant type 1 = Case Participant type 2 = Control	□ Specify:	**(7)Modality of Contact lenses wearer**	□ Regular User(wear CL for more than five days a week) □ Occasional User(wear CL less than five days a week)
(1)Age	□ Specify:		
(2) Date of Birth	□ Specify:		
(3)Gender	□ Male □ Female	**(8)SCL brand**	□ Specify: □ Do not know
(4)Level of Education	□ Not-educated □High school □ Diploma □ Bachelor □ Higher education	**(9)Actual Replacement Schedule (per patient)**	□ Daily □Biweekly □1- month □3- months □6- months □Yearly □ Other, Please specify □ Do not know
		(10) Your recommended follow up appointment	□ Specify: □ Do not know □ I was not told about follow up appointments

3) Compliance Status of Lens Wear and Care

Please put X on the answer that best describes your soft contact lens care and maintenance routine.

a) **Wearing and Replacement Habits**

Q. No.	Habit	Always	Often	Sometimes	Rarely	Never	Note
11	I WEAR my lenses as per the recommended wearing time each day (not more than 8 -12 hrs)						
12	I DISCARD my used contact lenses and switch to a new pair as recommended						
13	I do NAP (sleeping for short periods) in my contact lenses						
14	I sleep OVERNIGHT in my contact lenses						
15	If my eyes look RED OR IRRITATED, I remove my lenses as soon as possible						
16	I ATTEND all the recommended after-care visits suggested by my practitioner						

b) Disinfection Procedures

Q. No.	Procedure	Always	Often	Sometimes	Rarely	Never	Note
17	I WASH my hands before handling my contact lenses						
18	I use TAP WATER or saliva to disinfect my lenses if no disinfection solution is available						
19	I RUB my lenses with solution on both sides each time I disinfect them						
20	I RINSE my contact lenses with solution after the rubbing step						
21	I CHECK my lenses for debris & damage before insertion						
22	I use FRESH disinfecting solution to store / soak my lenses after each use						
23	When I soak my contact lenses, I FILL the lens case with enough fresh disinfecting solution to cover the lenses completely						
24	I SOAK my contact lenses in the disinfecting solution for more than 4 Hrs every night						

c) Care of contact lenses Accessories

Q. No.	Procedure	Always	Often	Sometimes	Rarely	Never	Note
25	I CLEAN my contact lens CASE well with antiseptic solution / soap and air-dry with the top off and the face down once a week.						
26	I allow the lens case to AIR-DRY with the top off and the face down after inserting my lenses each day						

27	I REPLACE the contact lens case every 3 months						
28	I SHARE my contact lens case with my others (family members or friends)						
29	I RECAP my solution bottle immediately after use						
30	I always CHECK the ‘discard-after’ dates of my contact lens solutions						

Appendix 2

استبيان

فعالية استخدام تطبيقات الهاتف المحمول على التزام وسلوك مرتدي العدسات اللاصقة اللينة في الأراضي الفلسطينية المحتلة

للاختصاصي فقط

العلامة التجارية للعدسات اللاصقة اللينة		**الفترة المعتمدة من قبل الشركة المصنعة لاستبدال العدسات**	
نوع الاستبيان	□قبل استخدام تطبيق الهاتف المحمول □بعد استخدام تطبيق الهاتف المحمول		

أسئلة المقابلة

1) البيانات السكانية		**2) تاريخ العدسات اللاصقة**	
كود المشترك الأحرف الأولى (الاسم الأول و العائلة) تاريخ الميلاد و العمر مثال : AS2411199128	□حدد:	**5) المدة الزمنية الكلية منذ البدء في استخدام العدسات اللاصقة**	□ ≥ 6 أشهر. □ 6 أشهر- سنتان □ > سنتان – 4 سنوات □> 4 سنوات
نوع المشترك Case=1 Control =2	□حدد:	6) **نوع العدسات اللاصقة**	□ تصحيح نظر (وصفة طبية) □ ملونة (بدون وصفة طبية) □ تصحيح نظر وملونة (وصفة طبية)
رقم هاتف المشترك	□حدد:	**7) تصنيف استخدام العدسات اللاصقة**	□ استخدام منتظم-(أكثر من ٥ايام بالأسبوع) □استخدام متقطع-(أقل من ٥ أيام بالأسبوع)
1) العمر	□حدد:	**8) العلامة التجارية للعدسات اللاصقة اللينة**	□ حدد: □ لا أعلم
2) تاريخ الميلاد	□حدد:	**9) جدول استبدال العدسات اللاصقة**	□ يومي □كل اسبوعين □ شهري □كل ٣ أشهر □كل ٦ أشهر □سنوي □اخرى-الرجاء التحديد □ لا أعلم
3) الجنس	□ ذكر □ أنثى	10) **موعد المراجعة الدورية الموصي به(بعد وصف و تركيب العدسات اللاصقة)**	□حدد: □ لا أعلم □ لم يتم إخباري بمواعيد المراجعة من قبل
4) المستوى التعليمي	□غير متعلم □الثانوية □دبلوم □ بكالوريوس □ تعليم عالي		

3) حالة الالتزام في الارتداء والعناية بالعدسات اللاصقة
الرجاء وضع إشارة (×) أسفل الإجابة التي تصف طبيعة ارتداءك و عنايتك بالعدسات اللاصقة .

أ) عادات الارتداء والاستبدال.

رقم س	العادة	دائماً	غالباً	أحياناً	نادرا	أبداً	ملاحظة
10	ارتدي عدساتي اللاصقة وفقاً لوقت الارتداء الموصى به كل يوم (ليس أكثر من 8 ساعات)						
11	أتخلص من عدساتي اللاصقة المستخدمة وأنتقل لاستخدام زوج جديد على النحو الموصى به.						
12	أنام لفترة قصيرة (قيلولة) في عدساتي اللاصقة.						
13	أنام طوال الليل في عدساتي اللاصقة.						
14	إذا كانت عينيّ حمراء أو متهيجة، أزيل عدساتي اللاصقة في أقرب وقت ممكن.						
15	احضر جميع زيارات المراجعة الموصى بها من الاختصاصي						

ب) إجراءات التنظيف والتعقيم

رقم س	الاجراء	دائماً	غالباً	أحياناً	نادرا	أبداً	ملاحظة
16	اغسل يداي قبل التعامل مع العدسات اللاصقة						
17	استخدم ماء الصنبور أو اللعاب لتنظيف العدسات في حال نفاذ المحلول الخاص بالتنظيف						
18	أقوم بتنظيف عدساتي اللاصقة يوميا بعد كل استخدام						
19	أقوم بفرك عدساتي اللاصقة مع محلول على كلا الجانبين في كل مرة أقوم بتنظيفها						
20	أغسل العدسات اللاصقة بالمحلول الخاص بعد خطوة التنظيف						
21	أتحقق من عدم وجود ترسبات أو أضرار في العدسات اللاصقة قبل الارتداء						
22	استخدم محلول جديد لتخزين / نقع عدساتي بعد كل استخدام						
23	عندما أقوم بنقع العدسات اللاصقة، أملأ علبة العدسات بمحلول جديد يكفي لتغطية العدسات بالكامل						
24	أنقع العدسات اللاصقة في المحلول لأكثر من 4 ساعات كل ليلة.						

ج) العناية في الملحقات

رقم س	الاجراء	دائماً	غالباً	أحياناً	نادرا	أبداً	ملاحظة
25	أقوم بتنظيف علبة العدسات اللاصقة جيدا باستخدام محلول/ صابون مطهر و أقوم بتجفيفه بالهواء مرة واحدة في الأسبوع						
26	أقوم بتجفيف العلبة في الهواء يوميا بعد كل استخدام للعدسات اللاصقة.						
27	استبدل علبة العدسات اللاصقة كل 3 أشهر.						
28	أشارك أصدقائي علبة عدساتي اللاصقة						
29	أعيد غطاء زجاجة المحلول بعد الاستخدام مباشرة						
30	أتحقق دائما من تواريخ انتهاء محاليل العدسات اللاصقة						

Appendix 3

نموذج الموافقة على المشاركة في البحث العلمي

عنوان الدراسة: فعالية استخدام تطبيقات الهاتف المحمول على التزام وسلوك مرتدي العدسات اللاصقة اللينة في الأراضي الفلسطينية المحتلة

اسم الباحث: عرين محمد امين الشلبي

الهدف من الدراسة:

1. تقييم تأثير استخدام تطبيقات الهواتف المحمولة (تطبيق Lensa) على التزام وسلوك مرتدي العدسات اللاصقة اللينة.
2. تقييم مستوى التزام مرتدي العدسات اللاصقة اللينة في الأراضي الفلسطينية المحتلة.
3. توضيح العلاقة بين مستوى التزام العدسات اللاصقة ومتغيرات متعددة مثل الجنس، التعليم، وطريقة الارتداء.

فوائد الدراسة:

1. زيادة وعي مرتدي العدسات اللاصقة بالعادات الصحية الصحيحة لارتداء العدسات اللاصقة واستبدالها.
2. زيادة الوعي بأهمية الالتزام بالخطوات الكاملة لتعقيم العدسات اللاصقة وبالتالي تجنب مخاطر حدوث التهابات في العين.
3. التركيز على أهمية العناية بملحقات العدسات اللاصقة بتعقيمها واستبدالها حسب ما هو مقرر.
4. تدريب المشتركين على استخدام تطبيق (Lensa) لمساعدتهم في تحسين مستوى التزامهم في التعليمات الصحية للعناية بالعدسات اللاصقة و تذكيرهم بأوقات ارتداء واستبدال العدسات اللاصقة.
5. التركيز على أهمية زيارة المراجعة بعد وصف وتركيب العدسات اللاصقة.

طريقة اجراء الدراسة:

الدراسة تتكون من مرحلتين تفصل بينهما مدة ثلاثة شهور، المرحلة الأولى تشمل اجراء الاستبيان الأول، تدريب على استخدام تطبيق (Lensa). بعد شهر ستكون زيارة المراجعة حيث سيتم فيها مناقشة ارتداء العدسات اللاصقة وعادات العناية بها للمساعدة في منع حدوث التهابات العين، والتأكد من استخدام المشتركين لتطبيق (Lensa).

المرحلة الثانية بعد ثلاثة شهور تشمل اجراء الاستبيان الثاني عن طريق الهاتف.

طريقة التواصل مع الباحث:

يمكنك التواصل مع الباحث من خلال الهاتف (0597256857) أو من خلال البريد الإلكتروني areen.shalabi@gmail.com، إذا كانت لديك بعض الأسئلة عن الدراسة.

حماية خصوصية المشارك وسرية البيانات:

جميع البيانات التي ستذكر في الاستبيان سرية ولن تستخدم إلا لأغراض البحث العلمي، المشاركة في البحث طوعية ويمكن للمشترك الانسحاب في أي وقت بشرط إخبار الباحث.

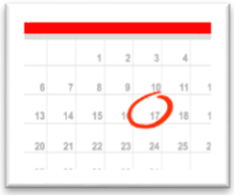
موافقة وتوقيع المشارك في البحث:

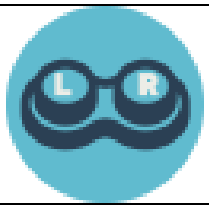
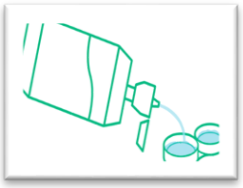
حصلت على شرح مفصل عن الدراسة وأهدافها وإجراءاتها، وفوائدها. أفهم كل المعلومات التي قدمت ووصلتني إجابة على كل أسئلتي.

أوافق على أن أشارك في هذه الدراسة بطوعية وبدون أي نوع من الاجبار أو الضغوط. أفهم ان بإمكاني التوقف عن المشاركة في أي وقت.

الاسم: _____ التوقيع: _____التاريخ:

Appendix 4

السلوكيات الخطرة المتعلقة بارتداء العدسات اللاصقة، والسلوكيات الصحية حسب التوصيات العالمية		
السلوكيات الخاطئة		السلوكيات الصحية
عدم ارتداء العدسات اللاصقة الملائمة		العدسات اللاصقة هي عبارة عن جسم غريب يلامس قرنية العين، وعلى المستخدم أن يخضع لفحص نظر شامل لأخذ وصفة العدسات اللاصقة المناسبة له.
ارتداء العدسات اللاصقة خلال فترة النوم او القيلولة		تجنب النوم في العدسات اللاصقة الا في حالات وصف عدسات لاصقة مخصصة للنوم من قبل أخصائي بصريات، حيث تبين أن النوم أثناء ارتداء العدسات اللاصقة أخطر من الإصابة بعدوى العين.
عدم الالتزام بغسل اليدين عند ارتداء العدسات اللاصقة		غسل اليدين بالماء والصابون وتجفيف اليدين بمناديل خالية من الوبر في كل مرة قبل لمس العدسات اللاصقة.
غسل أو نقع العدسات اللاصقة بالماء		الماء غير ملائم لتعقيم ونقع العدسات اللاصقة، حيث تنقل الماء الجراثيم إلى العين من خلال العدسات اللاصقة. تنظيف العدسات اللاصقة وحفظها لا يتم الا بمحلول العدسات الطبي المخصص للتعقيم.
ارتداء العدسات خلال السباحة والاستحمام.		تجنب الاستحمام في العدسات اللاصقة، وإزالتها قبل استخدام حوض الاستحمام الساخن أو قبل السباحة الا في حال استخدام نظارات السباحة.
غسل او تبليل العدسات اللاصقة باللعاب		تنظيف العدسات اللاصقة وحفظها لا يتم الا بمحلول العدسات الطبي المخصص للتعقيم، ولا تستخدم الماء أو اللعاب مطلقًا لتنظيفها.
عدم استبدال العدسات اللاصقة دورياً		جميع أنواع العدسات اللاصقة تنتهي صلاحيتها خلال فترة يتم تحديدها من الشركة المصنعة، فبعض العدسات تستبدل يوميا، أو كل أسبوعين، أو كل شهر، أو كل ٣ أشهر، أو سنويا. على المستخدم التأكد من التاريخ المحدد لتغييرها من الموقع الالكتروني للشركة المصنعة او من اخصائي البصريات الذي قام بوصف وتركيب العدسة، والتأكد ايضاً من العلامة التجارية الخاصة بالعدسة فلا يجوز ارتداء العدسات اللاصقة دون علامة تصنيع تشير الى اسم ونوع العدسة.

عدم تنظيف العدسات اللاصقة حسب التعليمات		فرك وشطف العدسات اللاصقة في كل مرة عند ازالتها باستخدام محلول التعقيم الطبي الذي يتم وصفه من اخصائي العيون فقط. على المستخدم التحقق دوما من تاريخ صلاحية المحاليل.
عدم تنظيف علبة العدسات دورياً		استخدام محلول التعقيم الطبي لتنظيف علبة العدسات وذلك بفركه من الداخل بواسطة بالأصابع لمدة ٥ ثواني، ومن ثم غسله مجدداً بالمحلول وتجفيفه باستخدام منديل خالي من الوبر. عند الانتهاء من عملية تعقيم العلبة، يتم قلب العلبة والغطاء، كل على حدا، في مكان نظيف وخالي من الميكروبات. يجب اتباع عملية التنظيف هذه يوميا لجميع مستخدمي العدسات اللاصقة. بالإضافة، من المفضل وضع علبة العدسات في ماء مغلي لمدة خمس دقائق ثم اتركها لتجف وهي مكشوفة ومقلوبة مرة أسبوعيا.
عدم استبدال علبة العدسات اللاصقة دورياً		يجب تغيير العلبة من شهر-٣ أشهر.
إعادة استخدام المحلول لأكثر من مرة لتعقيم العدسة		استخدم فقط محلول جديد لتعقيم العدسات اللاصقة وتجنب إعادة استخدام ذات المحلول لأكثر من مرّة واحدة للعدسات، أو خلط المحلول الجديد مع المحلول القديم أو المستخدم.
عدم المتابعة الدورية عند المتخصص		لا تهمل فحص العين الدوري عند المتخصص على الأقل مرة بالسنة، والتزم بمواعيد المراجعة المتعلقة بالعدسات الموصى بها. إن واجهت أي مشكلة في العين مثل الاحمرار او الغباش بادر بإزالة العدسة اللاصقة من العين والتواصل الفوري مع المتخصص المسؤول. من المفضل ان يكون بحوزتك نظارات طبية بحال اضطررت لإزالة العدسات اللاصقة.
مشاركة العدسات اللاصقة		العدسات الطبية التي تقوم باستخدامها هي لك بمفردك، ولا يمكن لأحد أن يقوم باستعارتها منك فهذا أمر خطر وقد يسبب انتقال الالتهابات الجرثومية في العين من شخص إلى آخر.
ارتداء العدسات اللاصقة بعد وضع مساحيق التجميل		ضع العدسات اللاصقة قبل وضع مساحيق التجميل. وضع العدسات بعد وضع مساحيق التجميل يجعلها أكثر عرضة للتلوث.
ارتداء العدسات اللاصقة بعد تجفيف الشعر		ضع العدسات اللاصقة بعد تجفيف الشعر بالمجفف (السشوار)، لتجنب تعريض العدسة والعين للجفاف بسبب تعرضها المباشر للهواء الساخن.

الملخص

الامتثال في العدسات اللاصقة هو التزام مرتدي العدسات اللاصقة بالتوصيات والتعليمات المقدمة من قبل اخصائيي رعاية العيون. من المرجح أن يعاني مرتدي العدسات اللاصقة الذين يظهرون التزاماً ضعيفًا في العناية بالعدسات اللاصقة وتعليمات الارتداء من مضاعفات تصيب العين. تعتبر الاستراتيجيات الحالية لتعزيز سلوك الامتثال للعدسات اللاصقة محدودة. الطريقة المعتمدة هي تثقيف المريض إما شفهيًا أو من خلال تعليمات مكتوبة معززة بالصور أو مقاطع الفيديو أو الكتيبات. بشكل عام، إحدى الاستراتيجيات المستخدمة لتعزيز امتثال المرضى في القطاع الصحي هي تطبيقات الهواتف المحمولة. تم استخدام هذه التطبيقات لضمان استمرارية الرعاية وتغيير السلوكيات الصحية السيئة، ومن الجدير تقييم فعاليتها في تحسين امتثال مرتدي العدسات اللاصقة.

الهدف

لتقييم فعالية تطبيق الهاتف المحمول (لينسا) في تحسين الامتثال والسلوكيات الصحية بين مرتدي العدسات اللاصقة اللينة في الأراضي الفلسطينية المحتلة.

المنهجية

كان تصميم الدراسة شبه تجربة، ويستخدم قبل / بعد التدخل ومجموعة تحكم قابلة للمقارنة. تم جمع البيانات باستخدام استبيان تم تصميمه لتقييم مستوى الامتثال على كل من مجموعة التدخل ومجموعة التحكم. تم تدريب مجموعة التدخل على استخدام تطبيق (لينسا)، وتلقوا تعليمات مكتوبة حول العناية بالعدسات اللاصقة وارتداءها، بينما تلقت مجموعة التحكم تعليمات شفهية فقط. تم قياس مستوى الامتثال لمجموعة التدخل ومجموعات التحكم ومقارنتها في نهاية الدراسة لتقييم أثر التدخل.

النتائج

أكمل ما مجموعه 201 مشاركاً الدراسة. تم تسجيل مائة وأربعة مشاركين (104) في مجموعة التدخل، بينما كان سبعة وتسعون مشاركًا (97) في المجموعة التحكم. كان متوسط عمر المشاركين 27.4 ± 7.38 سنة ، 91.5٪ منهم إناث، و 48.3٪ من المشاركين حاصلون على درجة البكالوريوس. كانت هناك زيادة ذات دلالة إحصائية في درجات الامتثال في أربعة عشر من أصل عشرين سلوكًا للعناية بالعدسات اللاصقة لمجموعة التدخل، وفي ثمانية من أصل عشرين سلوكًا لمجموعة التحكم

(Wilcoxon Signed Ranks Test, $p<0.05$) . كان تطبيق (لينسا) فعالًا في تحسين سلوك واحد فقط للعناية بالعدسات "وقت ارتداء العدسات اللاصقة يوميًا" (Mann Whitney U test ، -p).

value=0.03كانت نسبة مستوى الامتثال لكلا المجموعتين بعد التدخل 80.6 ٪ ، مقارنة مع 45.3 ٪ مستوى الامتثال قبل التدخل.

الاستنتاج

على الرغم من عدم وجود فرق بين التعليمات المقدمة من خلال تطبيق الهاتف المحمول / التعليمات المكتوبة والتعليمات الشفهية، أكد تطبيق (لينسا) فعاليته في التحكم في عدد ساعات الارتداء اليومية مع وجود فرق كبير بين التدخل ومجموعة التحكم، بالإضافة إلى التحسن في الامتثال للسلوكيات الأخرى على الرغم من عدم أهميتها احصائياً. هناك حاجة إلى مزيد من الدراسات لتقييم فعالية تطبيق (لينسا) لفترات زمنية أطول، باستخدام عينة كبيرة الحجم وأنواع أخرى من العدسات اللاصقة.