



Mobile Health Applications Used in Perinatal Period and Nursing Roles

Abstract

With the development of information and communication technologies, mobile health (m-health) applications have become a part of traditional health applications. The use of m-health applications to improve the pregnant, fetus, mother and newborn health has increased. M-health applications are used in the preconceptional period to improve the health behaviour of couples, to follow and evaluate the health status of pregnant woman and fetus in the gestational period, to inform women about the gestational period, and to improve health life-style behavior. There are many portable m-health applications such as tele-ultrason, mobile integrated doppler device in the follow-up of pregnant women who have limited access to health services. In addition, there are mobile applications that can follow the birth symptoms of pregnant women and provide psychological support during birth. Mobile partographs are used to manage birth process effectively. There are also mobile health applications to develop clinical skills of healthcare professionals about birth process. The applications used in postpartum focus on supporting breastfeeding process, avoiding postpartum complications and postpartum depression. In this whole special process, the use of m-health applications also contributes to the development of nursing care and education, and communication between multidisciplinary teams. The aim of this review is to research mobile health applications from preconception period to postpartum period and the related nursing approach.

Keywords: Mobile health units, Pregnancy, Birth, Postpartum, Nursing

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Acar Z, Oskay Ü. Mobile Health Applications Used in Perinatal Period and Nursing Roles. *J Educ Res Nurs.* 2021; 18(4): 451-456

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Submitted: December 3, 2019
Accepted: March 19, 2020



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Introduction

In recent years, the rapid development of information and communication technologies (ICT) in healthcare services around the world has resulted the development of mobile health (m-health) and important changes in the presentation of healthcare services.¹ Around the world, healthcare charges composes a vast majority of gross national product and these expenses increase gradually. However, despite all the expenditures, the quality of health services and access to health services are not at the desired level. "Today, the ownership of more than six billion mobile phones and over two billion smartphones globally raises the issue that mobile health will be one of the most important tools for improving health in the future."²World Health Organization (WHO) defines m-health as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices."³ In Turkish Industry and Business Association's "An Innovative Perspective on Health: Mobile Health Report" (2016), the mobile health has been defined as "mobile health has an application area in a very wide range from the shot messages (SMS) for raising awareness in public, giving warning and guiding about diseases to video teleconsultation and tele-visit applications; from getting an appointment by cell phone or the Internet to sending medical data from portable and wearable devices; from applying self-blindness test by smart phone applications to remote chronic disease management."⁴M-health applications are used for these purposes via portable medical devices, wearable technologies, home care technologies, smart phone health applications and SMS. M-health applications, which are used effectively in every field of health, are also frequently used in perinatal patient care. Although there are many m-health applications used in the perinatal period in the world, the use of these applications in Turkey is quite limited. The use of m-health practices in perinatal health services in Turkey will contribute to increasing the quality of care. In this research paper, it was aimed to review mobile health applications from preconception period to postpartum period and the related nursing approach.

The Place of M-Health Applications in the Perinatal Period

The main aim of care in the perinatal period is to protect the health of mother and child by providing appropriate prenatal care and eliminating related complications. Throughout the world, the rate of maternal death decreased by 38% from 2000 to 2017.⁵ 94% of all the maternal mortalities occur in low and middle income countries.⁵ Most maternal deaths are preventable and all women need access to high quality care during pregnancy, childbirth and postpartum.⁵ With the increasing use of mobile phones in recent years, it is thought that mobile health applications will be a force in improving preventive maternal health services.

WHO, Johns Hopkins University Global m-Health Initiative, United Nations International Children's Emergency Fund (UNICEF) mobile health workers and practitioners have jointly developed ICT Technologies within the framework of Mobile Health Applications and Reproductive, Maternal, Newborn and Child health (RMNCH) in order to define the mobile innovations implemented in the last 10 years in the field of reproductive health, maternal, newborn and child health and to ensure the continuity of care.⁶ Within this scope, 12 mobile health characteristics have been identified as the instrument of reinforcing healthcare system. These features are; patient education and behavior change, sensors and point-of-care diagnosis, records and vital events tracking, data collection and reporting, electronic health records,

electronic decision support: information, protocols, algorithms, checklists, provider-to-provider communication: user groups, consultation, providers for business planning and scheduling, training and development of providers, management of human resources, supply chain management, financial transactions and incentives.^{6,7}

The Areas of Usage of M-Health Applications in the Preconceptional Period

Preconceptional care aims to optimize women's health in the pre-pregnancy period and to reduce risks to fetus and newborn health.⁸ Dijk et al.⁹ determined in their study on the infertile and fertile couples planning pregnancy the fruit and vegetable consumption and folic acid intake of the couples increased and smoking and alcohol use decreased as a result of the 26-week individual online consultancy by "Smart Pregnancy" mobile application on nutrition, physical activity, folic acid intake, smoking and alcohol use in the pre-conceptional period.⁹ It is predicted that m-health application will improve care results as a way in providing and maintaining pre-conceptional care.

The Areas of Usage of M-Health Applications in the Pregnancy Period

The period in which m-health applications are most widely used in the prenatal period is the pregnancy period. It is used to monitor and evaluate the health status of the pregnant and fetus, to monitor chronic health problems that occur during pregnancy, to inform about the pregnancy process, and to develop healthy lifestyle behaviors.⁹ Lee and Moon¹⁰ (2016) determined in their study they assessed the content and use of the mobile applications used in perinatal period in Korea that 55% of the women used mobile applications mostly for obtaining information on the signs of danger, diseases, physical changes in pregnancy, prenatal training, breastfeeding and baby feeding. In another study, it has been stated that 45.3% of women need an expert to answer their questions in applications.¹⁰ Bush et al.¹¹ compared the women using and not using mobile applications in their study they conducted in the United States of America (USA) and determined that the women using mobile applications went for pregnant follow-up more and, therefore, they have had a lower rate of giving birth with low birth weight.¹¹ M-health applications are thought to be an important tool for pregnant women to reach the information and support they need regarding the pregnancy process.

Evaluation of Fetal Health Status

Many diagnostic and test methods such as double, triple, quadruple test, amniocentesis, ultrasonography, nonstress test, and contraction stress test are used to evaluate fetal health.¹² In accordance with this aim, it is observed that tele ultrasound and fetal heart rate monitorization system/mobile integrated doppler device are used most frequently.

Tele-Ultrasound

Tele-ultrasound is a device consisting of a wireless system that provides benefits in terms of being easily portable, transmitting ultrasound images remotely, and being low in cost. The TOCOMAT system, which is active in Italy, is a tele-ultrasound application that enables remote ultrasound monitoring of pregnant women at risk living in rural or remote areas. Results from the first six months of study with the TOCOMAT system show that it is technically easy to implement and accepted by doctors and patients, and can help reduce inequality in healthcare.¹³ Nader et al.¹⁴ determined in the study they conducted in the USA with 2386 pregnant women who were in the gestational week greater than the 16th week that tele-ultrasound had a close sensitivity with normal o-ultrasound (95.9%). In this respect, m-health practices

are thought to be beneficial in the evaluation of fetal health, especially in pregnant women living in regions with limited access to health services, and in providing information exchange among health professionals regarding this evaluation.

Fetal Heart Rate Monitorization System/Mobile Integrated Doppler Device

The use of today's nonstress test (NST) devices has been limited with hospital environment. It is possible to provide such health services technologically to all pregnant women in need without going to the hospital. The mDoppler device, which was developed within the scope of the thesis study in Turkey, detects and calculates the mother's uterine contraction signals along with the heart rhythm of the baby in the mother's womb, sends them to smart mobile devices, saves them as an original NST output and can be sent to any physician at any time. This device has facilitated the instantaneous data transfer of individuals to their registered physicians remotely.¹⁵ With the mobile NST devices, this assessment becomes possible especially in the situations when fetal health should be frequently evaluated in home environment. With all data being transmitted to the hospital database, diagnosis and evaluation processes can be continuously provided remotely, which can increase the possibility of early diagnosis.

Assessment of Chronic Health Problems in Pregnancy

One of the important areas where M-health applications are used during pregnancy is chronic health problems. The most common chronic health problems during pregnancy; hypertension and gestational diabetes during pregnancy. M-health applications are used in the early diagnosis, monitoring and management of these problems.

Preeclampsia

Maternal mortalities develop as a result of the complications occurring during pregnancy, birth and in the prenatal period. Most of these complications can be avoided or treated. Hypertension (preeclampsia and eclampsia) developing in pregnancy is one of these complications. Early diagnosis and appropriate management of preeclampsia is quite important in terms of maternal and fetus health, especially in avoiding the eclampsia table threatening life.⁴ For the early diagnosis of preeclampsia, a smartphone application based on the miniPIERS (mini pre-eclampsia integrated estimate of risk) model and a phone oximeter consisting of a pulse oximetry sensor have been developed. miniPIERS questions gestational age, systolic blood pressure, chest pain, shortness of breath, headache, visual disturbances and abdominal pain and vaginal bleeding, and the oximeter measures blood pressure.¹⁴ Ganapathy et al.¹⁶ developed a sphygmomanometer composed of a telephone all the functions of which were disabled except for its Bluetooth feature. The measurement results were coded with green, yellow, and red messages. If the phone screen is green, it means that it should continue to measure at normal frequency, if it is yellow it means that the measurement should be repeated every 4 hours and communicate with the health personnel, and if it is red, it means that the patient should go to the hospital without wasting time. In a study conducted with 50 pregnant women to evaluate the effectiveness of this device, which was developed for early diagnosis of preeclampsia; it was determined that 90% of the women stated that the application was simple to use, 78% preferred home monitoring with the device, and the rest preferred to continue to receive health services with the traditional care model that includes hospital and home visits by midwives.¹⁶ With this application, pregnant women can be evaluated continuously and early diagnosis of preeclampsia and eclampsia can be provided. Also, the participation of pregnant women to their own healthcare applications can be supported.

Gestational Diabetes

While the prevalence of gestational diabetes is seen between 1% and 14% of pregnancies all over the world; it is stated that it varies between 2.6% and 27.9% in our country.¹⁷ Guo et al.¹⁸ developed a blood glucose measurement device with which pregnant women can make their own blood glucose follow-up and the measurement values can be transmitted to hospital system spontaneously. In their study with 124 pregnant women with gestational diabetes, to investigate the effects of this application they developed on pregnancy weight management, blood sugar control, and pregnancy outcomes; it was determined that pregnancy compliance was high in the experimental group, made less frequent visits to the clinic, had lower HbA1c level and less weight gain.¹⁸ There are many mobil health applications on diabetes management. It has been stated that the pregnant women with gestational diabetes use these applications.¹⁹ Considering the negative effects of gestational diabetes on maternal and baby health, the health applications supporting the active participation of mothers in diabetes management have great importance. There is a need for m-health applications specific to the pregnant women with gestational diabetes.

Bringing in Healthy Lifestyle Behavior in Pregnancy

Bringing in healthy lifestyle behavior improves maternal and baby health. In the systematic review in which the results of 14 studies in which the effect of m-health on perinatal and postnatal care in the low- and middle-income countries were evaluated, Feroz et al.²⁰ determined that the use of SMS and voiced reminder applications focused on patient training and behavioral change in the perinatal and postnatal periods and m-health was more effective when it is used as an additional service with the routine healthcare.²⁰

Weight gain in pregnancy have effects both on the health of pregnant women and fetuses in the short and long term. Almost half of the pregnant women gain weight over the normal limit in pregnancy. Waring et al.²¹ examined the Internet and telephone use of the pregnant women living in the USA on healthy weight gain in their study and determined that 94% use the Internet and mobile applications to have information on pregnancy and baby and 86% of them use them for healthy weight gain.²¹ Willcox et al.²² determined in their study conducted with 89 pregnant women living in Australia to examine the effect of m-health application on gestational weight gain, physical activity, and health nutrition that the gestational weight gain was close to normal or less than normal in the ones using the applications and the physical activity performed has been less.²² M-health practices support healthy weight gain and regular physical activity for pregnant women by developing healthy lifestyle behaviors.

The Pregnancy and Newborn Diagnostic Assessment- PANDA

PANDA is a cost-effective, easy to use m-health system including WHO's antenatal care recommendations in which pregnant women and newborns are assessed. This system is composed of three components: a mobile device in which clinical and personal information is recorded (the device includes a training module including the danger signs about pregnancy, birth and newborn); "PANDA care point" including a bag including the materials such as thermometer, sphygmomanometer, urinary kit, glucometer and the software system named "PANDA medical unit" providing that physicians can control the data and form clinic tables with individual patients data.²³

Borsari et al.²⁴ determined in their study conducted with 150 sub-saharan immigrant pregnant women to examine the effect of PANDA on prenatal care that some pregnant women had anemia, gestational diabetes, preeclampsia, malaria, HIV and the pregnant women were

guided to a healthcare institution. In this study, as a result of the medical risk score given to each woman by the doctors, it was determined that 57.3% of the pregnant women were low-risk, 32.7% were medium-risk, and 10% were high-risk.²⁴

Health Promotion and Health Education Service on Pregnancy and Childbirth (Prenacell)

Prenacell is an m-health application that provides health promotion and health education services regarding pregnancy and childbirth via SMS. Ciabati et al.²⁵ sent SMSes to the pregnant women on including pregnancy and birth physiology, antenatal and postpartum care, contraception and the psychological side of pregnancy and postpartum period. As a result of the study, it was determined that the intervention group went to antenatal monitoring more frequently (>6 times), used folic acid and iron preparations, went to dental examinations, had oral glucose tolerance and serological tests done.²⁵ With m-health application, a training service can be provided for mothers which they can access "anytime anywhere" from pregnancy to postnatal period easily. It is considered that the women who access correct information with this training service will develop more healthy behavior in this period.

The Areas of Usage of M-Health Applications in the Birth Period

The follow-up of birth and birth process with appropriate methods in an appropriate way plays a key role in preventing maternal and infant mortalities.⁵ Birth follow-up includes three main topics: the factors related to mothers, the factors related to babies and birth process. Fetal heart rate, amniotic fluid color, cervical dilatation, uterine contractions, fetal descent, maternal blood pressure, and mental state are evaluated within the scope of birth monitoring. With the mobile health applications, it seems possible to improve the care quality during birth and decrease maternal mortalities, especially with the follow-up to be performed in the low-income countries.²⁶

mLabour

To prevent the problems and mortalities experienced during birth process, a mobile application named "mLabour" has been developed including a mobile partograph and the work flow on the birth process. This application starts by recording a pregnant woman, continues by recording the data on the birth process and provides that the birth process is performed more effectively. Mobile partograph application, as a component of mLabour, aims to decrease the obstacles to the use of partograph by focusing on interpretability, practicality, and developing time.²⁷ Many m-health applications that can be used in the management of the birth process are under development and supervision.

Mobile Integrated Wearable Electronic Fetal Monitorization

Electronic fetal monitorization is wearable system in which fetal heart rate and uterine contraction follow-up is performed spontaneously with a wireless and mobile device.²⁸ This system provides the mobilization of the pregnant women in the intrapartum period. The data on the system fall into the system of healthcare professionals and this makes follow-up easier and more effective. However, it greatly benefits pregnant women and health professionals in remote geographical areas that do not receive adequate antenatal services, have low fetal and maternal outcomes, and have limited access to health services.²⁸ In a study evaluating the effectiveness of a wireless integrated wearable electronic fetal monitoring device in the USA, it was reported that 87.5% of the pregnant women in the active phase were evaluated correctly, 65.6% of the pregnant women described the device as comfortable and 96.9% useful.²⁹ The mobile integrated wearable electronic

fetal monitorization devices can provide an easy way in which the pregnant women can move in comfort without being bound to bed and can have any birth position, participate in the birth process more actively, their and baby health can be followed at any time. For this reason, there is a need for more studies on the use of mobile integrated wearable electronic fetal monitoring devices.

Safe Delivery

Safe Delivery is a mobile health application formed to improve the clinical skills of healthcare professionals on delivery process. Lund et al.³⁰ reported in their study conducted with 3601 pregnant women and 176 healthcare professionals to examine the effect of the safe delivery app in the low-income countries on the knowledge and skills of the healthcare professionals about newborn resuscitation and perinatal mortality that no significant difference has been found between the pregnant women who have used and not used the app in terms of perinatal mortality and there was a significant increase in the knowledge and skill scores of the healthcare professionals in the experimental group.³⁰ With the M-health application, the knowledge and skills of health professionals who care for pregnant women during the birth process can be improved, and the development of maternal and infant health can be supported in this way.

The Areas of Usage of M-Health Applications in the Postnatal Period

M-health applications used in the postnatal period frequently includes SMS applications. With SMS support, it is often aimed to monitor the health of the mother and baby, to prevent postpartum depression and to support the breastfeeding process.³²

SMS Support

Lee et al.³¹ demonstrated in their systematic review and meta-analysis in which they assessed 12 studies examining the effectivity of the mobile health applications in maternal, newborn and child health in the low and middle income countries that the perinatal death risk has decreased in the children of the mothers who had SMS support during pregnancy and an improvement has taken place in morbidity or mortality, only in one study, compared to the routine prenatal care. In the meta-analysis conducted on baby feeding, it was determined that the prenatal interventions performed via SMS improved the breastfeeding rates one hour after delivery.³¹ Maslowsky et al.³² In his study in Ecuador, postpartum mothers were given training via SMS for 30 days and health indicators were examined in the postpartum third month; it was found that mothers mostly contacted the nurse to get information about breastfeeding, baby monitoring, organizing the home environment for the baby, family planning, bleeding, pain, voiding and defecation. However, as a result of the study, it was determined that breastfeeding rates were higher in the experimental group (who received sms support) in the postpartum third month, the transition to additional food was less, the child was followed more frequently, and the use of contraception was higher (most implantation).³²

Gallegos et al.³³ conducted a study in Australia to examine the effect of SMS application on breastfeeding rates and coping with breastfeeding self-sufficiency, they provided support with SMS (MumBubConnect) for the experimental group for 8 weeks, and they determined at the end of the ninth week that the breastfeeding rates were higher in the experimental group and they used active coping methods. But no significance difference has been found in this study in terms of self-efficacy scores between the groups.³³ In another study, the breastfeeding rate of the mothers in the experimental group in the first 6 months was found to be higher and transition to supplementary food after the fourth month has been found to be lower by providing SMS

support for the mothers each week starting from the third trimester during postpartum 12 months.³⁴

Niksalehi et al.³⁵ communicated with 54 mothers within 14 days after their delivery via phone and daily two SMSes were sent to the women with Postpartum Depression (PD) risk for 35 days in their study they conducted in Iran to determine the effect of remote consultancy service via SMS on the treatment of the mothers with PD risk. As a result of the study, it has been determined that the average Edinburgh Postpartum Depression Scale (EPDS) score has been 14.44 (SD = 2.66) before the intervention and the average score has decreased to 11.94 (SD = 2.49) after the intervention and there has been a statistically significant difference before and after the intervention.³⁵ Based on the results of this study, it may be mentioned that m-health applications provide support in the improvement of maternal and baby health, starting and maintaining breastfeeding, preventing postpartum depression, using contraceptive methods in the postnatal period.

Continuity of Care (Comm Care)

Continuity of care; adolescence, pregnancy, birth, postpartum period means the maintenance of care throughout the life cycle with the aim of improving the health and survival of mothers and children. Reducing the global burden of preventable maternal, neonatal and child deaths and morbidity is an important public health focus. To accelerate the progress about Millennium Development Goals (MDG) and Sustainable Development Goals (SDG) have become the highest priority in the global political agenda.⁴⁻³⁷ WHO last estimates have emphasized that approximately 295.000 maternal deaths occurred in 2017 globally.⁵ Within this scope, all mothers should access reproductive health services, access care during pregnancy and delivery and all children should survive and continue their development.

Commcare program is a mobile public health program of the United Nations supported by Gates Foundation for reaching the millennium targets about the mother and baby health.³⁷ With this program, the women are followed starting from pregnancy until the child reaches to the age of 6. Within the scope of this application, pregnancy, antenatal care, preparation for delivery, delivery, postnatal care, supporting breastfeeding, vaccination, supplementary food, the growth and development of babies are addressed. This application is especially used in the low and middle-income countries. In a study in India in which the effectivity of Commcare program has been assessed, 19,880 pregnancy and 19,888 children were registered in the health system between 2012 and 2015 after starting the use of the program and the continuity of care has been provided. Within the scope of the study, 309,733 home visits were performed for care services. As a result of the study, the pregnant women enrolled in the comm care program in the early stages of pregnancy; it was determined that they went to at least three antenatal follow-ups, took folic acid and iron supplements for at least 3 months, gave birth in a hospital, started breastfeeding earlier, and visited more homes.³⁷ Considering the above-mentioned positive results of this program on maternal and child health, its use in prenatal and postnatal follow-ups in Turkey can be recommended.

The Use of M-Health Applications in Turkey

Within the scope of the m-health applications developed by private persons and institutions, there are several Turkish applications included in Google Android and IOS operating system. These applications mostly include pregnancy follow-up. However, there are also limited applications that include the contraction counter, doula, signs of labor, puerperium, and infant care. For example; Turkcell Bebeğimi Beklerken/Büyürken (Waiting for my baby/Growing)

application provides SMS, MMS and video support for the first 12 months of babies for weekly/monthly development/information. Avea Anne Oluyorum/Bebeğim Büyüyor (I will be a mother/My Baby is Growing) applications is a support program informing future mothers via SMS. In our country, as well as the m-health applications developed by private institutions, there are general m-health applications such as the "Central Hospital Appointment System (MHRS)" and "E-Pulse" developed by the Ministry of Health.⁴ Formda Kal Türkiye (Stay Fit Turkey) that may be used develop healthy life behavior for pregnant women is composed of the parameters such as weight, body mass index, pedometer, calorie need.³⁸

Positive/Negative Sides of the Mobile Health Applications

Mobile health applications have an important role in increasing the effectivity and productivity of healthcare services. Especially in low and middle-income countries, many mothers die due to infections, eclampsia and postpartum hemorrhage complications during and after pregnancy. Most of these complications are preventable, and they compose approximately 75% of the maternal deaths. The antenatal and postnatal care applications have a key role in decreasing maternal deaths. The increasing use of information technologies in the world brings mobile health applications to the fore in health applications. These m-health applications are important in the perinatal period for providing safe and accessible healthcare services.^{38,39}

M-health applications used in the perinatal period; provide benefits in creating and updating patient records, monitoring the health status of individuals, and gaining healthy lifestyle behaviors. However, m-health applications; allow patients to benefit from health care services equally and participate in their own health care practices. M-health practices help health professionals to provide quality and effective health care to patients by improving their clinical knowledge and skills. However, m-health applications play a role in reporting health data and sharing data with local and national politicians and other stakeholders.^{38,39}

M-health applications have also negative sides besides their projected advantages. As m-health applications include personal and sensitive information, measures should be taken about its confidentiality and safety. The insufficient level of technology literacy in the society may prevent the effective use of m-health applications. Widespread use of m-health applications may lead to inaccurate access to health information, especially for pregnant women in the prenatal period. The issue of who will cover the cost of m-health applications creates uncertainty.^{38,39} That a general framework is presented with m-health applications and its limitations in providing individualized healthcare services may be mentioned among its negative sides.

Mobile Health Applications and Nursing

The scientific and technological developments result in the development and change of the roles and responsibilities of healthcare professionals. With the perinatal nursing approach, the pregnant/ puerperant woman and her family should be helped and guided to meet the education and care needs so that they can adapt to the new process physically, psychologically, and socially.⁴⁰ Today, perinatology nurses, who provide a mother and baby-centered holistic care approach, can use m-health practices as an important tool in providing effective health care. The use of m-health applications in informing pregnant and puerperal women who apply to the outpatient clinic or in perinatology services about the process they experience, gain healthy lifestyles, and monitor their health status will increase the quality of care and reduce the workload of nurses. However, it will provide an

opportunity for nurses who start to work in this field to improve their clinical knowledge and skills.

Conclusion

M-health practices have an important role in perinatal patient care. With these practices, it is aimed to improve maternal and infant health in the perinatal period, to prevent health problems, to diagnose, and improve them in advance. The m-health applications used in the perinatal period are limited in our country. There is a need for m-health applications that will be developed for the improvement of healthcare services considering today's technology. The perinatology nurses should be informed and encouraged about using these applications as a part of their changing and developing roles.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – Z.A., Ü.O.; Design – Z.A., Ü.O.; Supervision – Z.A., Ü.O.; Resources – Z.A., Ü.O.; Materials – Z.A., Ü.O.; Data Collection and/or Processing – Z.A., Ü.O.; Analysis and/or Interpretation – Z.A., Ü.O.; Literature Search – Z.A., Ü.O.; Writing Manuscript – Z.A., Ü.O.; Critical Review - Ü.O.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The author declared that this study has received no financial support.

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