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Integration of IOT For Maternal Health in Urban Environment for Efficient Reinforcement Training

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ABSTRACT

Internet of things can improve the well-being of pregnant women in Health Care Management. Pregnant women undergo early Bird Classes which improves their confidence level. During those classes they have to undergo antenatal exercise program during the first trimester of pregnancy. But the pregnant ladies often find difficult in doing the exercise program because of their changes in their vital parameters due to hormonal changes and the environmental changes like climate, temperature etc. These IOT devices measure the respiratory rate, heart rate, temperature, of both mother and fetus. So, she finds it easy to undergo the exercise schedule regularly through constant monitoring. Considering the environmental factors like temperature and humidity as extreme conditions can affect the well-being of pregnant women. These IOT sensors can trigger alerts or suggestions for adaption based on environmental conditions. Regular exercising of pregnant women decreases the pregnancy related complications and it also improves their health both physically and mentally (GHQ -12 Scale and PSQ1 Scale). This paper gives an overview of how the IOT devices helps in reinforcing the pregnant women to perform the planned exercise program schedule for the betterment of her future well-being.

1.Introduction

Pregnancy and childbirth have a profound effect on the female body. Pregnant women performing the physical activity during pregnancy is important and beneficial.[1] Low level of exercise programs like walking, running, jogging, Pilates, aerobics, strength training, yoga, swimming etc. are recommended by the Physiotherapist [5] during their antenatal period. But due to the hormonal changes and some common pregnancy problems like obesity, varicose veins, gestational diabetes [44], pregnancy induced hypertension [15], depression [28, 35,36], postnatal depression [45], Carpal tunnel syndrome [13,14], sleep apnea etc they are finding difficult to perform their exercise program. Internet of things for pregnant women's Healthcare makes all objects become interconnected [2]. By the use of RFID Tags and Wearable sensing units the vital parameters (Temperature, Blood Pressure, Heart Rate, Respiratory rate and fetal movement) of both the mother and fetus are constantly monitored [3]. By knowing the vital parameters with the help of IOT she will be able to do her daily exercise prescription regularly because IOT devices are monitoring her health constantly. [4]

Exercises are good for mind and body of pregnant women [6]. The challenges of pregnancy, parturition, taking care of the new born is not much easier. Corroboration confirms that exercise training program

scheduled and taught by the Physiotherapist will increase the well-being of Pregnant women by overcoming the pregnancy problems like breathlessness, morning sickness, extreme tiredness, mood swings [31] cramps, urinary stress incontinence, heartburn indigestion, constipation, headaches etc [7]. Timely monitoring of the vital parameters helps in identification of any health-related illness which can improve the Quality of the health of pregnant women. [8]. In recent years there has been a great improvement in technology in the field of Medicine and Health care. IOT [40] helps in interconnection of the objects and it is clever and smart that this will be recognized as next scientific revolution.

[9]. IOT [16,17,18] based smart Rehabilitation Systems with wireless systems and mobile systems using different types of sensors are becoming more and more efficient in improving the well-being of the pregnant women by monitoring the vital parameters. By using IOT devices like Flex Sensors, RFID Tags [21.23], pressure sensors, maternal heart rate monitoring sensors [37] fetal heart rate monitoring sensors the pregnant women can be monitored by the Doctors, Physiotherapist, Nurses, medical units anytime and anywhere with anything and anyone. There are different types of IOT [43] devices helping in the health care system. Pressure sensors for monitoring the blood pressure, acoustic sensors for monitoring the lung sounds, humidity sensors for detecting moisture, oximetry sensors for oxygen saturation, acceleration sensors for capturing the respiratory movements, Resistive sensors to detect the changes in breathing pattern, [3] standalone multi-parameter noninvasive sensing platform [8] continuous Glucose Monitoring System (CGMS) for monitoring gestational Diabetes[10], PSO based SVM classifier for GDM (Gestational Diabetes) [11].

Wearable's have the capability to make better the primiparous women and the provider (Physiotherapist) interactions for effective pregnancy health management,[41] chiefly for rural underserved populations. This also provides a cost-effective means for remote monitoring of higher risk women, [12]. The main challenge in our work is to identify the Primiparous women who accepts and ready to use the IOT devices during her exercise program and assessing her sleep quality by the Pittsburgh sleep Quality Index Scale (PSQI) the wellness by General Health Questionnaire (GHQ- 12) [39] Scale and Borg Scale for the level of intensity of the exercise program [42].

The Randomized Controlled Trait (RCT) carried in the Department of Physical Medicine and Rehabilitation. Primiparous Women who were interested in study were invited to undergo Physical examinations. After the confirmation they were separated into two groups. Since we have to measure the individual changes only two subjects were selected for experimental group who accepts for constant monitoring of vital parameters manually along with Exercise Program [48] and two for the control group who does only exercise program by monitoring her before and after the exercise program. The pregnant women were studied from the first trimester till the third trimester. Both the group was given the exercise programs. The duration of exercise program is 45 minutes. The session of Exercise program includes 5 minutes of breathing exercise (Diaphragmatic breathing) 10 minutes warm up walking, 20 minutes of strength training (Pelvic floor, back, abdomen, thighs, upper limb) and 10 minutes of Relaxation and Stretching exercises. The experimental group alone were continuously monitored manually their vital parameters. The sensors which measure the temperature, Heart Rate, Blood pressure and the Acceleration were provided to the experimental group they were monitored manually during the exercise program. The control group was told to do only the exercise program by monitoring their vitals manually only two times before and after exercise program.

2. Internet of Things

Internets of Things are the Physical devices which are used through internet. They are involved in the interconnection of the physical devices (different types of sensors) [19,20] that helps the devices to collect and transmit the results from the patients (here Pregnant women) with the help of Internet. IOT [22,31] devices are very easy for the continuous monitoring compared to manual monitoring [32,33]. For the well-being of the women in order to monitor the vital parameters we are using the health monitoring systems that takes the advantage of IOT. This allows the remote monitoring of patient status. Proper sensor network is required for proper monitoring in health care system. The Different types of sensors.

2.1 Temperature sensor

They are mainly used to measure the temperature of the body of maternal women. Due to the hormonal level changes of the Progesterone, increased metabolism, there is a slight rise in temperature. They can be placed in the mother's abdomen or used in wrist straps [47] or as a chain form in the neck. (DHT 11)

2.2 Maternal Pulse Rate and Heart rate Sensors

This is done by the use of the oximetry sensors which measures the oxygen saturation. It is placed in the finger tip of mother. These sensors [34, 38] have Infrared emitters that brighten a very little part of the skin which measures the absorption of light. This measurement [49,50] depends upon the oxygenation and de oxygenation amount of the blood. (EC 0567) AD 8232 ECG Monitor Sensor Module

2.3 Accelerometer Sensor

They are used to capture the movement of the fetus. This is the motion of the fetus caused by its own muscular activity. The American Pregnancy association states that advantages of conducting kick counts range from giving a pregnant woman an opportunity to bond with her baby. They are placed on the mother's abdomen to sense the baby's kick.

Table 1
Exercise program schedule

Duration	Types of exercise	Borg Scale – Load
5 min	Diaphragmatic breathing exercise	4
10 min	Walking	6
20 min	Strength Training exercise	7
10 min	Stretching & Relaxation exercises	6

The above table shows the exercise program schedule along with the duration and the level of difficulty level with the readings from Borg Scale Load. [2]. Diaphragmatic breathing exercises, walking, strength training exercises, stretching and relaxation exercises are represented in the above table.

Table 2
Vital Parameters and the sensors

Vital Parameter	Sensors used	Area of Placement in maternal body
Temperature Sensor	DHT 11	Wrist, Neck, Shoulder, Forehead
Maternal Pulse rate and heart rate	EC 0567) AD 8232 ECG Monitor Sensor Module	Finger tips
Fetus Movement	Accelerometer sensor	Abdomen

3. Proposed System

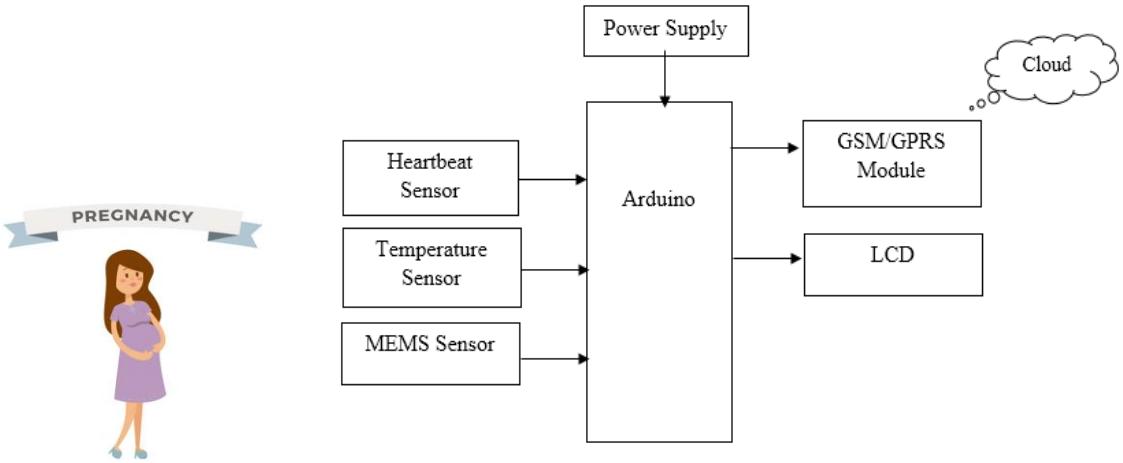

Fig. 1. Overview of training proposed

The above figure 1 represents the training period required for the mothers during the exercise program. A pregnant woman will be wearing a sensor [3] which represents her temperature, pulse rate, respiratory rate and that is being connected to the hospital management system. The hospital will monitor the status of the women regularly.

Table 3
GHQ – 12 Questionnaires

S.No	GHQ - 12	Using IOT		Only exercise	
		PT-1	PT-2	PT-3	PT-4
1	Been able to concentrate on what you're doing?	10	7.5	7.5	5
2	Lost much sleep over worry?	7.5	7.5	7.5	10
3	Felt you were playing a useful part in things?	7.5	10	5	2.5
4	Felt capable of making decisions about things?	7.5	7.5	5	5
5	Felt constantly under strain?	10	10	7.5	5
6	Felt you couldn't overcome your difficulties?	10	10	5	7.5
7	Been able to enjoy your normal day-to-day activities?	10	7.5	5	5
8	Been able to face up to your problems?	7.5	10	7.5	5
9	Been feeling unhappy and depressed?	10	7.5	7.5	7.5
10	Been losing confidence in yourself?	10	10	5	7.5
11	Been thinking of yourself as a worthless person?	10	10	7.5	5
12	Been feeling reasonably happy, all things considered	10	10	5	5
	Total	110	107.5	75	70

Table 4
PSQI Scale

S.No	**PSQI - SCALE**	**Using IOT**		**Only exercise**	
		PT-1	PT-2	PT-3	PT-4
1	Global Score	1	1	1	2
2	Sleep Quality	1	1	1	2
3	Sleep Latency	1	1	2	1
4	Sleep duration	0	1	2	3
5	Sleep efficiency	1	1	1	2
6	Sleep disturbance	1	1	2	2
7	Sleep medication	0	0	0	0
8	Day time sleep dysfunction	1	1	2	1
	Total	6	7	11	13

The General Health Questionnaire (GHQ-12) consists of 12 items each assessing the severity of the mental problem over the past few weeks using a four-point scale (from 0 to 3). The Pittsburg sleep quality index (PSQI Scale) is a self-support Questionnaire that assesses sleep quality over a one-month time interval.

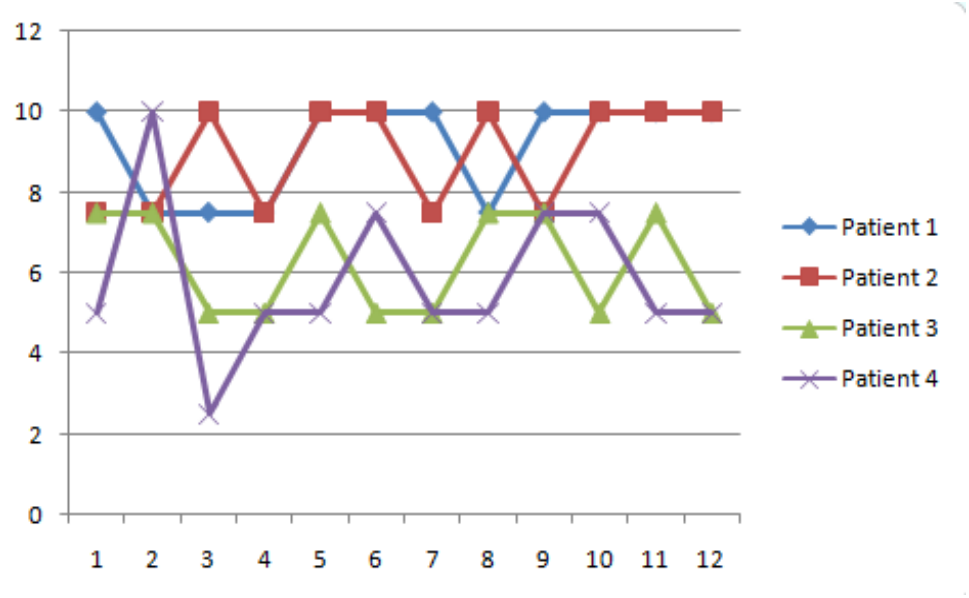

Fig. 2. GHQ - 12 Questionnaires

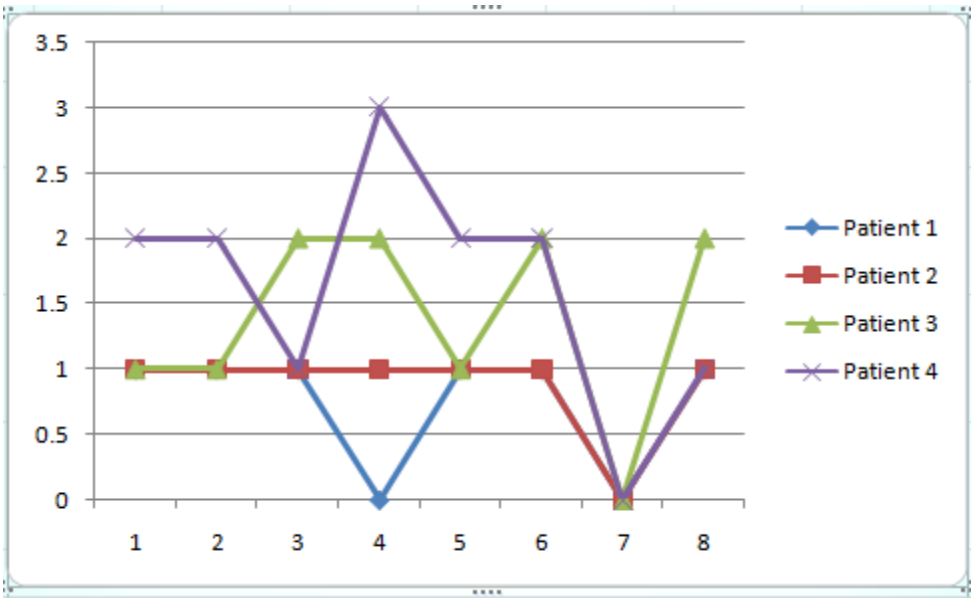

Fig. 3. PQSI Scale

The GHQ - 12 Questionnaire and PSQI scale which are shown in table 3 and table 4 respectively shows the effectiveness of the exercises which are measured in two groups the experimental group and control group. The former using IOT with exercises gives good responses than the later. The figure 2 indicates the responses of the pregnant ladies who are using the IOT devices along with their scheduled exercise program who are referred as patient 1 and 2 and the responses of the women who perform only exercises without using IOT by using the GHQ - 12 Questionnaire. From the figure 2 we are able to determine that the experimental groups are performing more desirable than the control group. Figure 3 is the scoring key for calculating the primiparous women's sleep quality by the PSQI scale. The sub scores of it are ranging from 0 to 21. The higher the score the worse is the sleep quality. Here one could see that the quality of sleep and the efficiency of sleep is improved in experimental group rather, the control group goes for further more sleep disturbances.

4. Conclusion

The primiparous women had a strong positive attitude towards the exercise program when given along with the IOT devices which is been illustrated from the GHQ 12 Questionnaire shown in table 2 with the values of 110 and 107.5 for the Patient 1 and 2 of experimental group compared to the control group whose values are 75 and 70 respectively for the patient 3 and 4. Sound sleep is very essential for the pregnant women for her physical well-being. The sleep efficiency, latency, quality, duration and her sleep disturbances during the day time and night time were measured using the PSQI scale in table 3 specify that the experimental group are having good sleep patterns with the score of 6 and 7 than the control group of 11 and 13 who are having more sleep disturbances. The use of IOT devices assists her in overcoming the barriers due to pregnancy related problems. It assists the women's exercise behavior from target to measures of action. Due to limited number of studies of IOT in exercise programming of the pregnant women further research is expected to confirm and extend the understanding of the IOT devices towards pregnant women. The IOT application of systems must also consider and guarantee the Privacy [24.25] and dignity [29, 30] of the pregnant women [26,27]. If the primiparous women are satisfied with the exercise program along with IOT then it will be a future reinforcement for her next baby. By establishing a network of IOT enabled monitoring system that transmit real time health data in urban environment is very useful for the maternal and fetal health.

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